Petroleum Engineer

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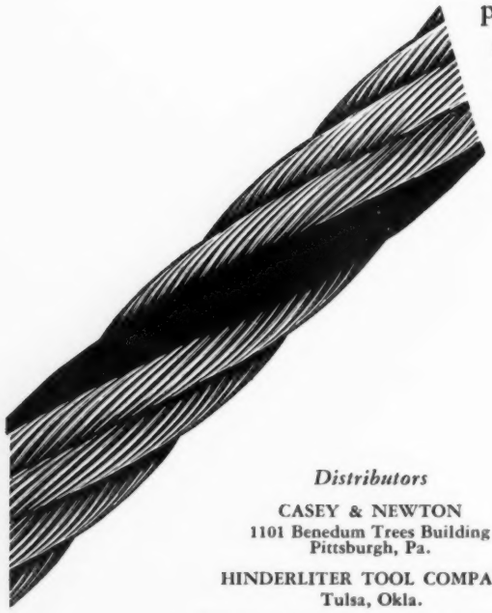

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SUBSURFACE PRESSURE DATA ...a Powerful Working Tool for the Production Engineer

By K. C. SCLATER

OF special import is the application of bottom-hole pressure data to the solution of the proration problem in the East Texas field. It is a progressive step that will foster sound principles of oil production.

Information compiled from sub-surface pressure readings taken in a selected group of wells at regular intervals in the East Texas field during the past year has given a comprehensive picture of the trend and magnitude of the changes in reservoir pressure that occur as the oil and gas are withdrawn from the pool.

For each million barrels of oil produced it is estimated that a decrease of one pound in the average pressure throughout the reservoir results. Obviously, the recent reduction of the field allowable from 310,000 to 290,000 barrels daily should prolong the flowing life of the field.

The rate of change of reservoir pressure over the field is not uniform. Great differences have been observed. It is known that certain conditions, namely, variation of the thickness and permeability of the pay sand, hydrostatic pressure and density of drilling, have a potent influence on the capacity of a well to produce and on the change in reservoir pressure that occurs. If equitable production is to be obtained from individual tracts or leases the influence of these factors must be counteracted.

It was to aid in accomplishing this end that the original Buck plan of proration for the East Texas field was promulgated by the Railroad Commission. According to this plan one-third of a well's allowable was to be based on both acreage and bottom-hole pressure. Strong opposition to the acreage clause was voiced by a number of operators, apparently on the ground that it was too discriminative in its application and would work an undue hardship on the owners of closely spaced wells in the field. The acreage consideration was deleted and as the order now stands, 250,000 barrels of the field's allowable will be allocated on a straight per-well basis and the remaining 40,000 barrels on a bottom-hole pressure basis.

In a field such as East Texas it is logical that sub-surface pressure be given some weight in producing operations. Regulation of bottom-hole pressures provides a means for the proper control and equalization of water encroachment. Just how great a part water encroachment will play in the exploitation of the field is still a matter for conjecture. This fact makes it seem all the more imperative that reliable information on reservoir conditions obtained by means of sub-surface pressure readings should not be overlooked. The valuable practical nature of the information is enormous.

From what field investigations have been made up to the present it has been amply demonstrated that though the information obtained from an analysis of sub-surface pressure data has a sound scientific basis it also has an immediate application to the solution of almost every type of practical production problem.

It is important to the producer to know the probable life of his wells so that plans can be made ahead for equipping them instead of waiting until they stop flowing. It is equally important for him to know the flowing characteristics of his wells in order that the methods and equipment best adapted to their economical operation may be selected. This type of information is of a highly practical nature, that will lead to rapid improvement in oil field practice.

Sub-surface pressure data have also a wide application to problems of reservoir depletion and will aid in providing an accurate check of the oil and gas reserves in a pool. This phase alone in the application of sub-surface data opens up a broad field of investigation.

One of the most difficult of the problems that confront the production branch of the industry today is that of well-spacing. A reasonably accurate knowledge of reservoir conditions in the first development stages of an oil pool is essential to the working out of a proper well-spacing program. To improper well-spacing can be traced many of the ills from which the production branch of the industry is suffering today. Sub-surface data, while they may not directly show what the sand and physical conditions in the reservoir are, do show the combined effect of the several factors while the well is producing, which information, after all, is what chiefly interests the producer. It is expected that sub-surface pressure data will throw much light on many of the problems that enter into well-spacing.

Economic factors and a rapidly accumulating engineering knowledge of reservoir conditions have combined to hasten the application of sub-surface pressure readings to the problem of proration in the East Texas field. The practical application of this comparatively new phase of engineering field practice merits the attention of every oil producer.

HIGHLIGHTS in OILDOM

Crude Price Reductions

Immediately following the announcement on December 14, by The Texas Company that it would pay lower prices for crude, Standard Oil Company purchasing subsidiaries in the Mid-Continent initiated a price slash materially below the previous posted schedules. The Standard's schedule, averaging a reduction of nearly 35 cents per barrel, was accepted by all crude buyers, thereby completely wiping out the difference in prices paid during the previous 60 days. Oklahoma, Kansas and North Texas 36 gravity crude is now bringing 69 cents a barrel compared to a price of $1.04 prior to December 14. (See page 10 for additional crude prices.)

Shut Down East Texas Field

The East Texas oil field was completely shut down for a two weeks' period, effective December 17. The State Railroad Commission ordered the suspension of production so that bottom-hole pressure gauges might be made throughout the field.

The shutting down of production in this field relieved the industry of over 325,000 barrels daily and caused the output of the Nation to drop to 1,698,150 barrels daily average for the week ending Dec. 31, 1932, which is the lowest daily production average for any week in nearly ten years.

New East Texas Proration Schedule

Upon compilation of data secured from taking bottom pressures in the East Texas field, the Railroad Commission issued a new proration order which took effect January 10. The order arranges for a minimum production of 26 barrels per well with an additional two barrels for bottom-hole pressures up to 1000 barrels. For each 100 pounds of bottom-hole pressure above 1000 pounds an additional 0.6 of a barrel is allowed, the maximum being 31 barrels daily. Total production of the field is not to exceed 290,000 barrels per day. Revisions will be made on the per well allowance on February 1 and March 1 to provide room for new completions. The order expires April 1.

New Basis for Figuring Crude Prices Inaugurated

An interesting feature of the month was the initiation of a new basis for figuring crude oil prices. Effective January 1, the H. F. Wilcox Oil & Gas Co., began purchasing and paying for crude oil on a basis of the price of United States Motor gasoline below 57 octane. For each one-eighth of one cent so quoted for such gasoline it will pay 2½ cents per barrel for oil of 40 gravity and above, and for all oil below 40 gravity it will discount its price 2 cents for each degree downward to below 29 gravity. This schedule with below 57 octane gasoline at 3 cents a gallon would call for payment of 60 cents a barrel for 40 and above gravity crude and 36 cents for 29 and below grade oil.

Tax Investigators Ascertaining Taxable Value of Natural Gasoline Pipe Lines

Representatives of the Internal Revenue Department have recently been in Tulsa and that vicinity for the purpose of ascertaining the location of natural gasoline pipe lines, the methods of operating them and the specific duties they perform in order to determine whether they may be included as common carrier gasoline pipe lines for tax purposes.

California Still Above Production Quota

Crude oil production in California has not approached the allowable outlet of 440,000 barrels daily, and there is doubt whether the allowable will be reached with the present setup. An excess of nearly 30,000 barrels is being produced daily. This oil is being absorbed, but it is questionable just how long the major companies will continue to handle the burden.

An interesting feature of the California situation has been the steadier gasoline price structure of the past year. This encouraging factor has been influential in maintaining California crude prices.

Forfeiture Law Hits Violators

A truck carrying 450 gallons of gasoline has been declared forfeited to the State of Louisiana by Judge Provosty in civil district court at New Orleans. The contents were said to be bootleg gasoline on which no taxes had been paid. This is the first forfeiture under the new Louisiana law that provides for the seizure.

Michigan Prices Increased

Central Michigan crude oil producers were given a 10-cent per barrel increase in crude prices, effective Dec. 31, 1932. The raise was not generally anticipated and is accounted for as a result of better marketing conditions and an increased demand for Michigan crude from pipe line companies. The present price of Michigan crude is 95 cents per barrel. Production of the Michigan fields has declined to 16,000 barrels daily, a loss of approximately 8,000 barrels in the past six months.

Texas Production Near Market Demand

Recent proration orders of the Texas Railroad Commission have brought the state crude oil production nearer the actual market demand than any previous order. The output of the state is to be curtailed to 757,150 barrels daily.

This reduction in production should bring a more healthful condition to the industry, and especially should it eliminate much of the distress oil in the East Texas field. There have been as many as 300 wells in this region without pipe line connections and some of this oil was offered at ridiculously low prices.

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Latest Activities in the Oil Fields

THERE were very few important developments in the production division of the oil industry during the past month. Perhaps the most outstanding was the abandonment of several promising wildcat tests.

The Conroe area, Montgomery County, Gulf Coast, Texas, continues to be the most closely watched spot in the Mid-Continent and will be a vital factor in determining the Nation's production status during the year 1933. It is now 4½ miles wide and over 5 miles long. In this area of 23 square miles less than 100 wells have been completed, which fact gives it high rank as a potential producer. In addition, the field has opened up a large wildcatting campaign along the entire Gulf Coast that is expected to make this territory the most active in the state.

Southwest Texas is also another important region and will play a big part in the state's oil history during the year 1933. The most important development last month in this large territory was the extension of the Tuleta field, Bee County, 1½ miles southwest by an estimated 15,000,000 to 20,000,000-foot gasser.

Another important development in this district was the extension to the southwest of the Laurel pool of Webb County. This pool, heretofore controlled by one operator, has had a close development, but a drilling boom of considerable proportions is expected to develop as a result of the new extension. Production is found from 2200 to 2275 feet, with initial flows ranging as high as 2500 barrels daily of 47 gravity oil.

The abandonment of ten wildcat tests in the East Texas region has removed possibilities of the industry being faced with new producing areas in this territory, at least for the present.

In California, the Kettleman Hills field was apparently further defined when at outpost test to the northwest of the North Dome shut down at 9935 feet without finding production. Some predict the well yet has chances of being productive. Wildcatting in the state continues fairly active with a large portion of it located in the area north of the Los Angeles Basin.

Two wildcats in the vicinity of the recently opened pool near Perry, Noble County, Okla., are being carefully watched as they near critical depths. New work in the state is widely scattered and very slow. The Seminole field has settled down and signs indicate it is slipping rapidly. Water encroachment has increased until more water is being produced in this field than oil.

The west side of the Fish pool, in the active Wewoka-Holdenville area, has apparently been defined by a test finding water in the Wilcox sand.

The Nickel pool in northwestern Harvey County, Kansas, was given a one-half mile east extension during the month. The well is estimated good for 50 to 60 barrels per hour, but is still in for tankage. Several important wildcats in the state should be completed within the next couple of weeks and will have an important bearing on the amount of activity in the state.

AVERAGE CRUDE OIL PRICES

California		Oklahoma	.69
Playa Del Rey	$ .78	Arkansas	.44
Coalinga	.55	Louisiana	
Long Beach	1.00	North Louisiana	.69
Montana	.75	Gulf Coast	.80
Wyoming	.92	Illinois	.87
Colorado	.92	Kentucky	.82
New Mexico	.50	Indiana	.52
Texas		Ohio	
North Central	.69	Lima	1.00
Panhandle	.60	Wooster	.95
West Texas	.50	Michigan	.95
Gulf Coast	.80	Pennsylvania	
Darst Creek	.60	Bradford	1.72
East Texas	.75	Corning	.85
Kansas	.69	West Virginia	1.37

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending December 28, 1932

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbls.	Gas and Fuel Oil Stocks Thousands of Bbls.
East Coast	99.1	436,000	68.3	12,249	8,244
Appalachian	95.0	79,000	58.5	1,772	793
Ind., Ill., Ky.	97.5	279,000	65.8	6,766	3,428
Okla., Kans., Mo.	84.9	199,000	51.0	4,763	2,706
Inland Texas	65.4	83,000	46.7	1,491	2,066
Texas Gulf	97.7	415,000	76.6	6,228	8,083
Louisiana Gulf	97.3	84,000	59.2	1,277	2,697
No. Louisiana-Ark.	88.5	43,000	54.4	306	475
Rocky Mountain	90.8	26,000	18.8	1,135	461
California	94.6	441,000	50.9	15,083	99,417
Total Dec. 28, 1932	91.6	2,085,000	59.0	51,070	128,370
Total Nov. 26, 1932	91.9	2,126,000	60.0	49,084	132,904

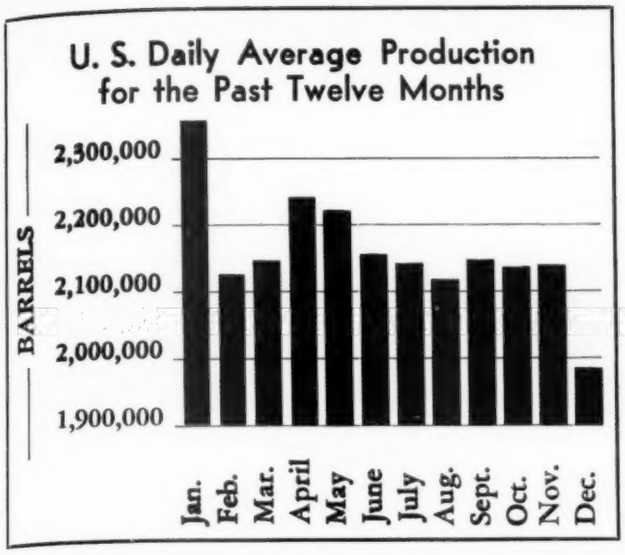
Daily Average Production

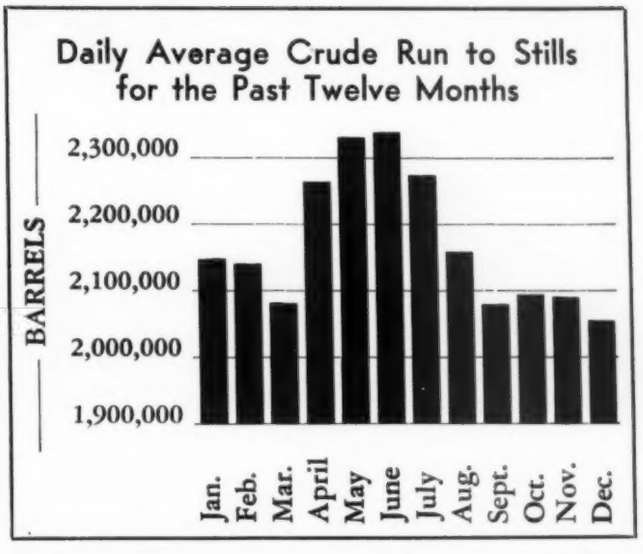
(Figures in Barrels)

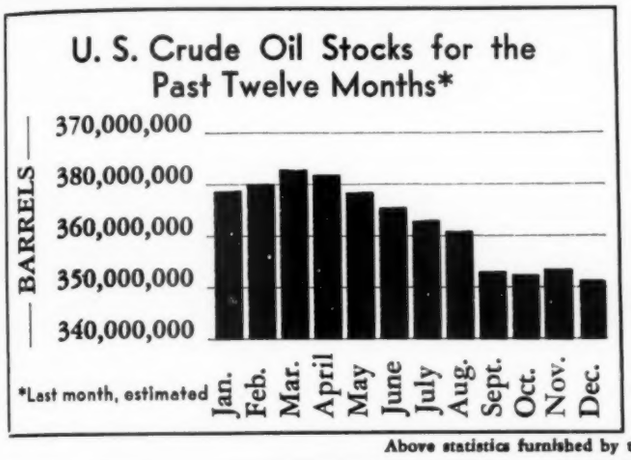
	Week Ended Dec. 31 1932	Week Ended Nov. 29 1932	Week Ended Dec. 26 1931
Oklahoma	336,900	336,800	534,950
Kansas	89,850	102,200	105,550
Panhandle Texas	44,450	45,450	51,750
North Texas	47,300	47,850	54,350
West Central Texas	24,250	24,750	26,250
West Texas	156,550	165,150	175,600
East Central Texas	50,150	49,300	50,300
East Texas	(a)	360,000	316,000
Southwest Texas	52,200	53,300	55,200
North Louisiana	29,500	28,900	27,550
Arkansas	32,800	34,050	33,050
Coastal Texas	131,150	123,850	115,700
Coastal Louisiana	33,950	34,800	29,700
Eastern (not including Mich.)	92,950	96,800	108,250
Michigan	17,500	19,250	16,250
Wyoming	29,850	34,600	37,800
Montana	5,900	6,400	7,800
Colorado	2,700	2,750	4,000
New Mexico	27,850	31,450	43,250
California	472,600	471,600	499,600
TOTAL	1,698,000	2,099,250	2,292,900

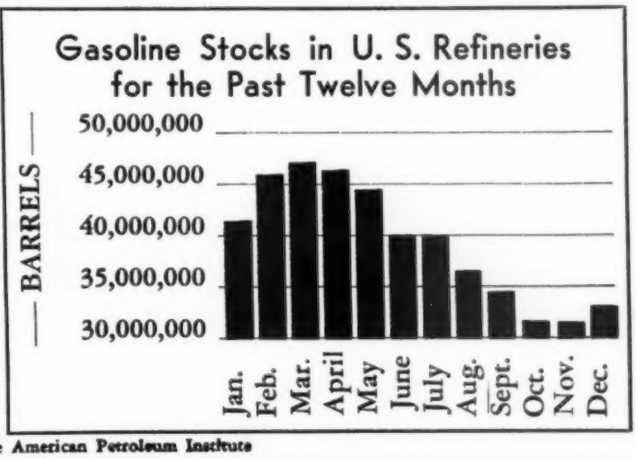
(a) East Texas entirely shut in.

NOTE: Stocks at refineries, except in California district, which includes stocks on finished gasoilne and engine distillate at refineries, water terminals and sales distributing stations and amounts in transit thereto.









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for December, 1932

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	400	395	316	233	248	3600	2	40	Rotary
Duval County	20	17	36	19	45	2300	2	22	Rotary
Panhandle	21	18	12	11	40	2900	2	40	Rotary
Conroe	27	26	54	27	62	5200	2	38	Rotary
Oklahoma									
Oklahoma City	10	9	9	7	21	6500	3	39	Rotary
Kansas									
McPherson	10	9	25	17	53	2900-3400	2	38	Rot.-Cab.
Ellsworth Arch	8	2	8	13	31	3300	4	37	Cable
California									
Kettleman Hills	2	2	3	2	12	8300	3 or 4	40	Rotary
Long Beach	7	7	2	2	6	7000	3	26	Rotary

Field Activities by States for December, 1932

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1931 (in Barrels)
	November	December	November	December	November	December	November	December	November	December	
Arkansas	3	4	1	0	2	3	9	10	23	24	15 425,000
California	19	21	15	20	18	21	10	10	99	99	188,575,000
Colorado	2	1	1	1	2	1	10	9	62	71	1,510,000
Illinois	8	0	3	0	0	0	2	1	14	10	4,850,000
Indiana	16	19	7	14	....	....	3	1	67	70	830,000
Kansas	59	45	33	26	43	53	52	40	108	102	37,950,000
Kentucky	39	30	25	18	....	....	12	6	54	48	6,490,000
Louisiana	51	41	29	15	37	45	42	39	124	105	22,325,000
Michigan	26	20	17	15	16	19	36	53	66	67	3,730,000
Mississippi	2	2	1	2	1	3	1	2	13	14	Gas. Prod.
Montana	7	5	3	4	9	4	7	9	41	52	2,855,000
New Mexico	7	10	5	9	10	10	5	12	47	56	15,250,000
New York	9	11	8	11	....	....	3	3	9	8	3,400,000
Ohio	51	67	24	54	....	....	36	25	110	121	5,315,000
Oklahoma	114	100	59	63	87	115	121	118	309	339	177,750,000
Pennsylvania	92	51	80	45	....	....	12	9	97	65	11,225,000
Texas	719	712	503	577	556	692	345	320	912	951	330,720,000
West Virginia	18	24	13	17	....	....	12	20	37	42	4,480,000
Wyoming	3	2	2	2	....	....	10	9	62	71	14,725,000
Total	1245	1166	829	705	782	976	728	696	2254	2315	847 413,000

Progress of Major Pipe Line Work

By WARREN L. BAKER

CONSTRUCTION of new gasoline pipe lines and extension of many natural gas lines continue to be the chief work in the pipe line industry. This type of work is expected to be the most important development during the next 12 months. Foreign countries are leading in the construction of new main line crude carriers.

Gasoline Lines

Laying will start at once on the 80-mile gasoline line of the Pure Oil Company to be built from Toledo, Ohio, to Hamtramck, Mich., an industrial center of Detroit. The line will be of six-inch seamless pipe with welded joints. The Sun Oil Company will have a minority interest in the project. The line will be used to transport motor fuel to the centrally located terminal, where it will be delivered by trucks to outlets in Detroit and surrounding area. The Sun Company has a 12,000-barrel refinery at Toledo and the Pure Oil Company a 9000-barrel capacity plant. The Detroit Southern Pipe Line Company has been incorporated under the laws of Michigan for the purpose of operating the line.

The United Gas Corporation, Houston, Tex., has finished a two-inch gasoline line from its Latex station, Texas, to Waskoma, Texas. The line, having a length of ten miles, provides for the delivery of natural gasoline from the Latex plant to recently built loading racks on the L. & A. railroad.

Nothing definite has as yet been announced on the proposed White Eagle Oil Company gasoline pipe line from its Augusta, Kan., refinery to Kansas City, Mo. Some reports are that the company will lease a line from the old Prairie Pipe Line Company's system and other rumors are that arrangements will be made with either the Phillips Pipe Line Company or the Great Lakes Pipe Line Company for the shipment of gasoline to Kansas City, but it is considered more likely that a new line will be built. It is possible that extensions will be built beyond Kansas City, with St. Louis, Mo., the most probable line. The distance from Augusta to Kansas City is 125 miles.

Natural Gas Lines

Interests attempting to develop markets for the natural gas production of Central Michigan continue their efforts to secure city and village franchises and pipe line permits. Thus far, they have not secured certificates of necessity and convenience for the laying of lines from the State Utilities Commission. Companies attempting to secure certificates are: Michigan Natural Gas Company, West Michigan Gas Company, and Miller-McCloskey interests of Tulsa, Okla. The latter, headed by J. P. McCloskey of Tulsa, propose a 40-mile line from the Mt. Pleasant producing district to eight central Michigan towns. The Consumers Power Company has entered into an agreement with the Michigan Natural Gas Company whereby the latter company will build a gas line from Mt. Pleasant to Saginaw and Bay City. The Michigan Natural has secured permission for the construction of the line, which will be 60 miles in length.

Over 200 miles of pipe line are proposed in a blanket application filed with the Board of Railroad Commissioners of Iowa by the Natural Gas Pipe Line Company of America, Chicago, Ill. The company seeks permission to extend its present holdings in Iowa to more than 20 cities in the state. Actual construction is not contemplated now and the application is merely a move to obviate the necessity of making extension applications from time to time.

The Texas Company has asked for and received bids on a 24-mile gas line between Lea and Hobbs, N. M. Gas will be piped from Hobbs to Lea to supply power for pumping wells.

The Leflore Gas and Electric Company, Poteau, Okla., has completed a 16-mile gas line connecting its Red Oak field with its other lines at a point near the outskirts of Heavener, Okla. The line is constructed of six-inch spiral weld pipe with multiseal couplings. It was necessary to construct this line to provide sufficient capacity for the winter load.

Standard Gas Company, Inc., previously known as Dickson County Oil and Gas Company, has awarded a contract to the Southern Engineering and Appraisal Company, Nashville, Tenn., for the design and supervision of construction on a 30-mile eight-inch line from Dickson County to Nashville. The company has secured practically all of the right of way but in certain sections is being delayed in finishing this work.

Many short lines and extensions are being built in widely scattered areas of the country.

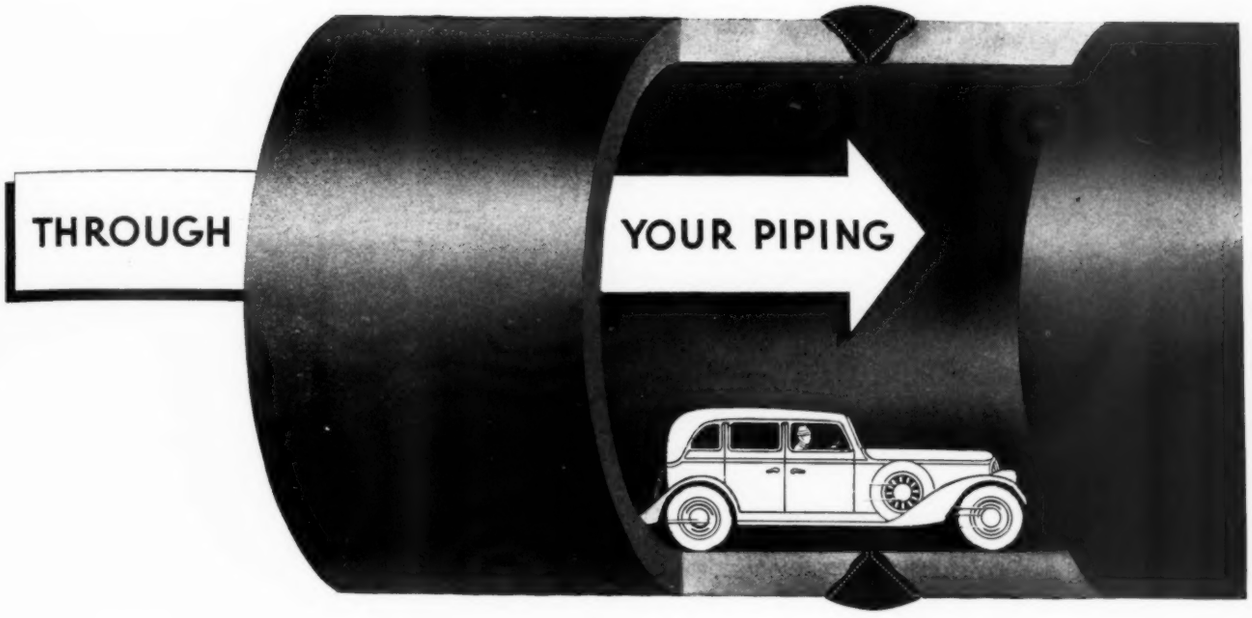
Crude Oil Lines

Foreign construction operations are the most important crude oil line work. Construction work on the Iraq Petroleum Company's 1200-mile line outlet from the Iraq fields, the largest construction job now under way, is getting into full swing. Work on the French portion of the line between Tripoli and Homs is reported proceeding satisfactorily. Some 600 workmen and their overseers are engaged. Dredging operations at Haifa, the terminus of the British-controlled fork, are progressing and it is expected that within a few months the harbor will be able to accommodate deep-draft vessels. Early announcement is looked for regarding plans for booster station construction and operation.

Another outlet for Iraq production is proposed by the Mosul Oil Fields Company, Ltd., which has completed arrangements for the exploitation of the extensive oil holdings of the British Oil Development Company, in Iraq. A 500-mile line outlet is expected to be constructed. Arrangements have been made with the Mannesmann Tube Works and the Good Hope Iron and Steel Works, both German concerns, for contractual rights to deliver steel for pipe and other equipment.

The Continental Oil Company, Denver, Colo., is understood to be making a survey for a route from Maverick Springs field, Wyoming, to railroad facilities at either Shoshoni or Riverton, a distance of 50 miles. It will probably be a six-inch line.

If you had to drive a Car



you would *demand* WELDED JOINTS

IN piping with smooth, one-piece, welded joints, fluids and gases speed along under normal power, like a car over paved highways. Added pressure, to overcome the resistance and turbulence that less efficient types of joint produce, is unnecessary.

But this is not the only economy that oxy-acetylene welding offers. It also cuts insulation, erection, and maintenance expense—eliminates special fittings and calking—reduces weight and adds strength.

The many advantages of oxwelded piping are explained in the book, "Oxwelded Construction for Modern Piping Services," which includes illustrated descriptions of welded overland, power, steam, refrigeration, and residence piping. Presenting the salient facts concerning the welding of steel and wrought iron piping, "Oxwelded Construction for Modern Piping Services" contains numerous money-saving suggestions in a form convenient for quick reference. Send for a copy today. You will be under no obligation.

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The Month's Activities in Refining*

By F. R. STALEY

THE Winkler Koch Engineering Company has been awarded a contract for the erection of a distillation unit at the Cyril, Okla., refinery of the Anderson-Prichard Oil Corporation.

The M. W. Kellogg Company will build a 10,000-barrel cracking plant for the General Petroleum Company at the Torrance, Calif., refinery.

The Rio Grande Oil Company is installing a pressure distillate stabilizing unit at Vinvale, Calif.

The percentage of cracked gasoline manufactured in California during the first half of 1932 increased to 25 per cent of the total production, compared with 21 per cent for the first half of the previous year. Many new cracking units are being erected in California refineries, which will further increase the percentage of cracked gasoline.

C. Knox of Enid, Okla., plans to build a small refinery near Graham, Tex.

The Union Oil Company will build a pressure distillate stabilizing unit at Longview, Wash.

C. W. Fourl plans to erect a 4000-barrel refinery at Signal Hill, Calif.

The Bell Oil and Gas Company, Tulsa, Okla., will remodel and enlarge the Dubbs cracking unit in the Grandfield, Okla., refinery, increasing the charging capacity to 50,000 barrels monthly. The finished yield will be 50 per cent of 75-octane gasoline.

Deliveries of Turner Valley crudes to refineries in Calgary, Canada, during 1932 showed a marked decrease over those of the previous, being only about 50 per cent as much.

The production of the French petroleum refineries for the year 1932 shows a decided decrease over the previous year.

The new refinery of the Shell Oil Company at Burnaby, British Columbia, received its first cargo of crude from California, and will start operations this month.

A survey of the high sulphur crude oils of Wyoming has been published by the U.S. Bureau of Mines. These black oils contain greater amounts of lubricating oil stocks than many well-known crudes, but are difficult to refine, due to their high asphalt and sulphur contents.

The American Society of Testing Materials has recently issued its yearly index to A.S.T.M. standards and tentative standards. It is designed to be of service to those interested in the field of engineering materials and the allied testing field.

A symposium on Motor Lubricants will be developed by A.S.T.M. Committee D-2 for the New York regional meeting of the Society to be held in New York City, March 8.

Natural Gasoline

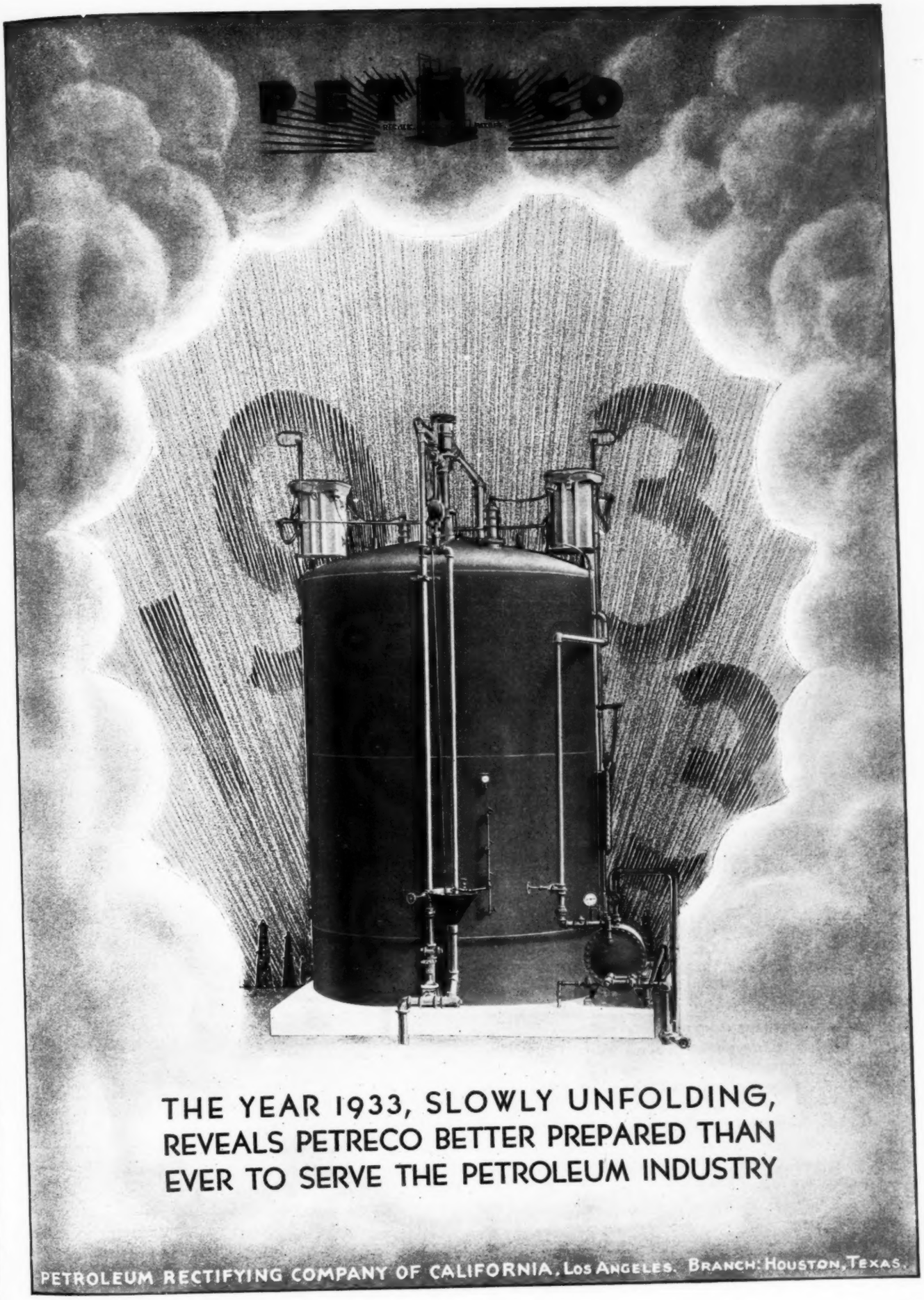
Petroleum Engineering, Inc., Tulsa, Okla., has designed and built four stabilizing units for the Texas Company's gasoline plants in Oklahoma and Kansas.

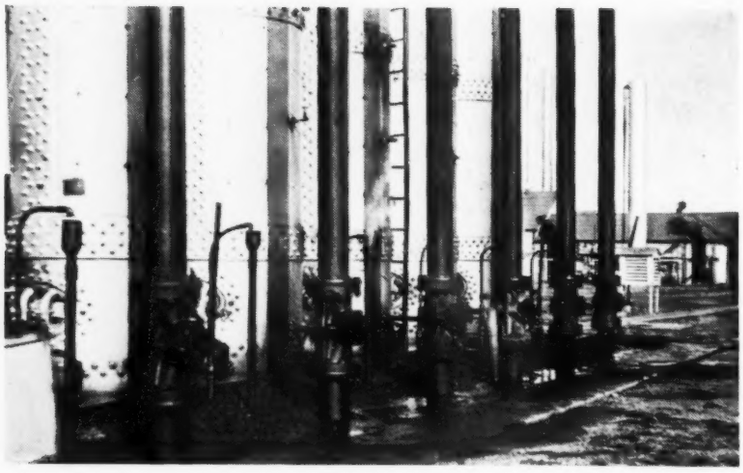
Natural gasoline stocks in California continue to increase possibly due to the increase in cracking capacities and new vapor recovery plants in refineries.

Stocks at refineries Dec. 3, 32,330,000 barrels
Daily average to stills in November, 2,008,000 barrels.

Figures in red show per cent refining capacity operated.

*All statistics as of January 1.


PETRECO
THE YEAR 1933, SLOWLY UNFOLDING,
REVEALS PETRECO BETTER PREPARED THAN
EVER TO SERVE THE PETROLEUM INDUSTRY
PETROLEUM RECTIFYING COMPANY OF CALIFORNIA, LOS ANGELES. BRANCH: HOUSTON, TEXAS.



Eight-inch, lubricated, plug valves installed on absorber flow lines at Lone Star Gas Company's Gordon, Texas, natural gasoline plant

Chemical and Mechanical Problems Involved In Gasoline Plant Operation

By F. R. STALEY

THE Lone Star Gas Company's natural gasoline plant at Gordon, Texas, is one of the most interesting in the Ranger district. Star gas, liquefied propane, is one of the products manufactured, most of which is transported to points of consumption in steel cylinders by motor truck.

The plant is located on a 20-inch main line, but it can be readily by-passed to avoid any interruption of gas flow in the main line that might result from fire in the gasoline plant. For by-passing the plant four gate valves are installed in a shallow concrete pit located about a hundred yards from the absorbers. These consist of two 20-inch gate valves on the main line, and an 18-inch gate on each of the branches to and from the absorbers. In case of emergency the two valves on the line are opened and the plant valves closed. Safety guards are installed over the gears to protect the operator.

The plant is of the absorption type, and has a daily capacity of 100 million cubic feet. The gas enters a battery of six absorbers under a pressure of 300 pounds per square inch. The absorbers are Tulsa-type, fabricated with riveted joints, and designed for 450 pounds working pressure. They are each 28 feet high and 48 inches in diameter. A 37 API gravity absorption oil is used. The gas enters and leaves the absorbers through 8-inch lines, each equipped with a horizontal check valve at the top of the absorber and a Nordstrom venturi-type lubricated valve in the vertical line near the ground level. By closing these 6-plug valves all of the gas can be shut off. During operation the absorption towers are blown down every hour to eliminate scale and dust deposits.

The rich oil is distilled in a Newton still equipped with a knock-back tower. The condensing and cooling coils are installed in the water cooling tower, the latter being constructed of redwood. Three stabilizers are operated in the plant. The raw gasoline is fed to a Jackson stabilizing unit, the bubble tower is 50 ft. high and 48 in. in diameter. Nielan pressure regulators and Foxboro temperature controls are used on the unit. Four Dean pumps are installed to handle the volatile liquids for the unit, each being 10 in. by 26 in. by 12 in. steam-driven. The first pump delivers the raw gasoline to the surge tank, the second handles the feed to the tower, while the other two are reflux pumps. Usually only a 26-70 natural gasoline is manufactured at the plant.

In the second stabilizer the butane is separated from the lighter fractions contained in the distillate from the first stabilizer. The butane is then used as a refrigerant for the propane stabilizer in which the ethane is removed and the almost pure propane or Star gas is made. The ethane is put back into the gas line and the butane is used as fuel in the plant or returned to the line.

A quantity of from twenty to forty thousand gallons of natural gasoline is produced daily. This is sweetened continuously in a two-tower treating plant with hypochlorite solution prepared at the plant from lime and chlorine gas.

Water used in the plant is obtained from a creek. It is pumped into a steel tank having a capacity of 37,500 barrels and is located in the plant. About 100,000 gallons are required daily. The water is very hard and is treated with lime and soda ash. The treating process is carried on in a concrete basin containing six compartments, the first being the hot well. Herein the lime is fed into the water continuously through a small hopper, a small water wheel in the line making this operation automatic. When the water is muddy alum is added to settle the suspended matter. The lime precipitates all of the carbonate or temporary hardness constituents as well as the permanent hardness due to magnesium compounds. The soda ash throws out the remaining hardness.

Six 150-hp. boilers supply the steam for the plant. Electricity for the lights is generated by means of a direct-current generator driven by a gasoline engine. Three 150-hp. Cooper-Bessemer compressors, gas engine-driven, and a 300-hp. Ingersoll-Rand steam-driven compressor are used for vapor recovery in the plant.

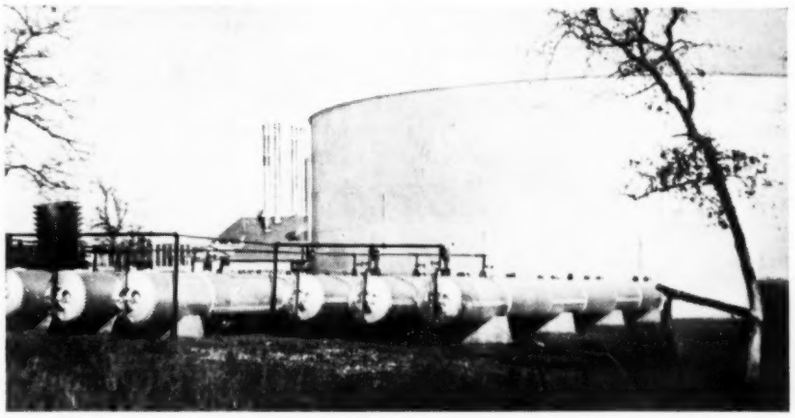
Star Gas

The liquefied propane is stored in nine horizontal tanks built for 300 pounds working pressure. They are slightly inclined so that any water that might settle out can be drained off. Before filling into the cylinder it is dehydrated and a small amount of a non-corrosive odorant is mixed with it. The full cylinders weigh 225 pounds and contain 95 pounds of liquid propane. Necessary tests are made at the plant in a pressure tank. Whenever the permanent expansion of the cylinder is greater than 10 per cent of the temporary expansion which occurs during a test it is rejected for use.

Commercial propane invariably contains appreciable amounts of dissolved and often entrained water unless it has been subjected to special dehydration treatment. Removal of this water becomes imperative if uninterrupted fuel service is to be assured, since the water-saturated product has been shown to give considerable trouble when it is used in cold weather. Experience has demonstrated that, at temperatures between 25 deg. F. and 35 deg. F. conventional propane pressure-reducing regulators tend to "freeze up" when operating on the vapors distilling from a water-saturated product. This trouble has been traced to the refrigerating effect obtained on expanding the vapors through the regulator valve, which results in the valve becoming colder than the surrounding atmosphere, whereupon a partial condensation from the water-saturated propane vapor takes place on the upstream side of the valve. Since liquid propane will dissolve only a small proportion of the water contained in saturated propane vapor, most of the water condensed with the propane remains behind as ice, while the liquid propane blows through the valve and is vaporized on the downstream side. The ice deposit gradually builds up as the regulator is used until the valve is so effectually blocked with ice that it will no longer operate.

Test for Moisture

K. H. Hachmuth[1] of the Philgas Company has described a simple procedure for indicating humidity in any gas or vapor. Cobalt bromide has the property of changing color with variation in humidity of the gas or vapor surrounding it. Each color change occurs at a definite per cent relative humidity. The apparatus used consists essentially of a glass tube containing a wad of cotton impregnated with cobalt bromide. One end is fitted with a standard pipe connection and the other with a fine capillary orifice. The method can be used to indicate the humidity of any gas or vapor that does not have a deleterious effect on the chemical. Strong acid vapors, ammonia, pyridine and alcohol vapors ruin the indicator.



Horizontal 300 pounds working pressure tanks used for the storage of the liquefied propane product. Each tank holds 95 pounds of propane.

At the present time, forces as well as expenses have been reduced and every possible bit of service must be obtained from a piece of equipment before it is junked, the gasoline plant operator is frequently confronted with unusual problems both mechanical and chemical. Some of the specific problems involved are water treating, lubrication of high-pressure cylinders, packing high-pressure rods, and corrosion of equipment.

Welding is now employed extensively in natural gasoline plants, both in construction and repair work. Bronze welding is very successfully used for the repair of gray iron castings and, when properly made, the weld is stronger than the cast iron. The welding is done in place and no preheating is required. Through the development of high-strength bronze welding rods the welded part has a tensile strength of 60,000 pounds per square inch at the weld. Chrome-Nickel allows of the 18-8 type are adaptable to welding. Welding of special alloys of Molybdenum, copper, nickel and silicon have presented special problems all of which have been successfully solved. Weldability is now regarded as one of the very important properties of a metal used in gasoline plant or refinery construction or in equipment.

Corrosion

In recent years considerable progress has been made in combating corrosion of refinery equipment through coöperation of petroleum chemists and metallurgists employed by various manufacturing companies. By the proper application of alloys or the use of neutralizing chemicals losses are minimized. Shaffer and Pollock[2] recently described the use of ammonia as a protective agent in non-pressure refining equipment. By the injection of the ammonia gas into vapor lines immediately before the condenser the iron loss of equipment was reduced from 75 to 95 per cent. Water was injected to carry off the ammonia salts.

Absorption Oil Manufacture

One of the plants in the Ranger district has installed a plant to top Ranger crude. From the fractionating tower a straight run gasoline cut is made and blended with some of the natural gasoline produced in the plant to manufacture motor fuel. A side stream is taken from the tower and used for absorption at the plant. This operation reduces freight costs considerably. In the first place a saving is effected on the transportation of crude to the refinery; another is made in the gasoline freight from the refinery to the Ranger district, and a third in the freight on the absorption oil. This particular company operates several gasoline plants in the Ranger District and has a refinery operating 100 miles from the plant.

Research

Chemists employed in the natural gasoline industry have been working on new outlets for the products. Recently many new uses and products have been developed, using natural gasoline hydrocarbons. A few of these developments are the manufacture of benzol under pressure and a suitable catalyst. Lubricating oils have been manufactured from ethylene in the presence of aluminum chloride. From the pentanes primary, secondary and tertiary amylamines, amyl mercaptan, amyl sulphide and other compounds have been produced.

[1] Western Gas, January, 1932.

[2] A.P.I. Houston meeting, 1932.

Latest Welding Methods Used on California Lines

By WALLACE A. SAWDON☆

WHILE pipe line construction has been reduced to a minimum during the past year or two, developments have been made during this period to aid in the reduction of construction costs and at the same time to improve workmanship and facilitate the laying of lines. Better joints for welded lines and improved methods of welding have materially assisted in bringing about these results on many gas lines in California; and the latest designs of joints, together with the newest methods of welding, have cut down costs and resulted in better lines.

Both oxy-acetylene and electric-arc welding remain popular as methods for welding; and close attention to joints made by each has been given on the larger diameter lines laid during the past year. In some cases both methods have been used on the same line, some sections being welded with gas and others with the electric arc, joints best suited to the particular method applied naturally being used in each case. The design of joints has governed the method of welding to be used and the recent types of joints furnished by manufacturers have been developed specifically for one method or the other.

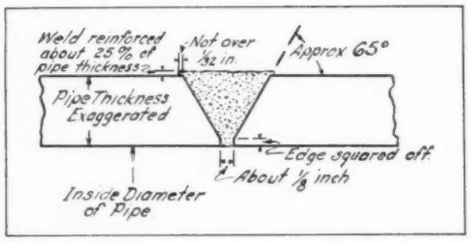
The saving of rod material and increased speed of welding operations have probably been the greatest factors toward further economies in pipe line construction. Nothing has been sacrificed in the quality of the work and there has, if anything, been a tendency toward improving the finished line by the use of the new joints and the latest welding technique. The organization of the welding crews—whether the work is to be done by gas or by electric arc—will always remain a factor in economic and speedy construction, but the new methods and materials will naturally assist the best organization in attaining better performance.

The gas welding process developed about a year ago to attain greater speed in oxy-acetylene welding with less rod consumption has been used with satisfactory results on several of the larger lines laid in California. This process increases speed in welding by means of a special flame adjustment, a special rod and a particular welding technique. The saving of rod material arises from the use of a bevel of 60 to 65 degrees, instead of 45 degrees, on the end of the pipe and from the fact that the ends of pipe may be welded very close together by the elimination of distortion. The joint made by the process is illustrated in Fig. 1, which shows all the features on the finished job. The butt-welded joint here shown has a space of but 1/8 inch between the ends of the pipe and this, with the 65-degree angle of the bevel, gives a very narrow weld along the outer perimeter of the pipe. There is but little melting of the parent metal of the pipe in making this kind of weld and the joints, even with hardly any breakdown, when tested have shown satisfactory results.

This particular process of gas welding is best done with butt welds and the straight butt weld with the proper bevel is satisfactory for the smaller diameter pipe. With larger sizes, however, a liner has been found advisable. The type of liner and the bell ends developed for the 24-in. and 26-in. lines laid in California are shown in Fig. 2, which gives a cross section to scale, showing the details of construction. This liner is dished in the middle of its outer perimeter and permits the fusion of the liner to the bottom of the weld, thus making it an integral part of the joint. The stream-line effect of both the bell ends of the pipe and of the inside and outside faces of the liner will be noted. The inside diameter of the liner corresponds with the inside diameter of the pipe and the spacers keep the bell ends of the pipe at the proper distance apart. There are four of these spacers, which are merely punched-up sections of the thin part of the liner and their width is 3/32 inch. The welding process is that described for the straight butt weld with the 65-degree bevel and close ends.

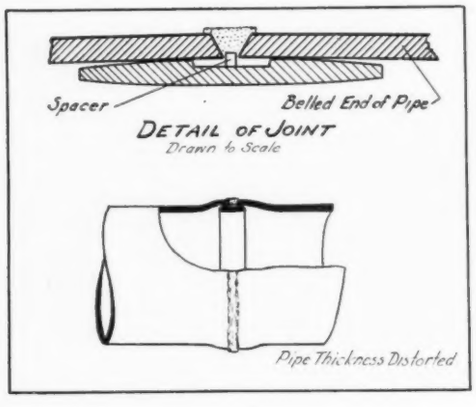
A joint that has been widely used for electric welded gas

☆ Petroleum Engineer, Los Angeles.

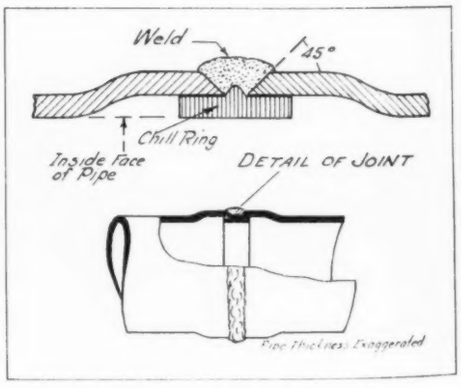


Right: Figure 1, illustrating the new type of butt weld made with the oxy-acetylene method

Below: Figure 3, showing the double bell joint with chill ring which has been used in California to a considerable extent for electric arc welding of lines during the past year



Left: Figure 2. Bell joints with this type of liner have been used on the larger diameter pipe with the new gas welding method



lines of large diameter is shown in Fig. 3. This, too, is a double bell joint and is used with a chill ring, which corresponds to the liner used with the oxy-acetylene process. The chill ring facilitates stabbing and aligning but its spacer is in the form of a welding dam, which extends completely around the outside circumference of the ring. The dam, of course, keeps the ends of the pipe at the proper distance apart and also assists in making sure the pipe is properly butted up to its correct position.

While this joint probably uses more rod material than the old bell-and-spigot type with welding dam it has superseded, it offers other advantages that are in its favor. The inside diameter of the chill ring is the same as that of the pipe itself and the thickness of the ring is usually the same as that of the pipe. The ends of the bells are beveled to 45 degrees and the process of welding is the same as straight electric arc butt welding.

The semi-automatic torch for the gas welding process has also been used to some extent on the lines laid in California during the past year. This torch with its two-flame blow pipe, automatic gravity feed rod holder and other mechanical features is probably well known to all interested in welded pipe lines. It has, however, served to aid in speeding up gas welding operations; but it involves the new welding technique necessary with the speedier oxy-acetylene process and welders not familiar with both this technique and the semi-automatic torch itself will probably have to prepare themselves in its operation.

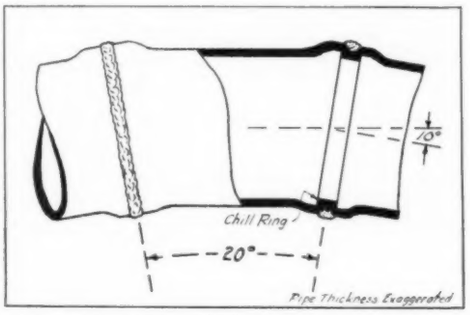


Figure 4: Factory-made bends have greatly facilitated the laying of lines and are being used to change both horizontal and vertical directions

Factory-made bends have been used to a considerable extent on the large-diameter lines and have been found to facilitate changes in direction both horizontally and vertically. At the present time these bends are being furnished for 5-deg., 10-deg., 15-deg., and 20-deg. angles for both gas and arc welded lines. Combinations can be made up to fit whatever amount of change in direction is necessary, and while they probably speed up the laying of the line they also assist in insuring a better line. In Fig. 4 is shown a bend for a 20-degree change in direction, with bell ends to fit corresponding bells on the straight pipe and with ample provision made in the design for a chill ring or liner.

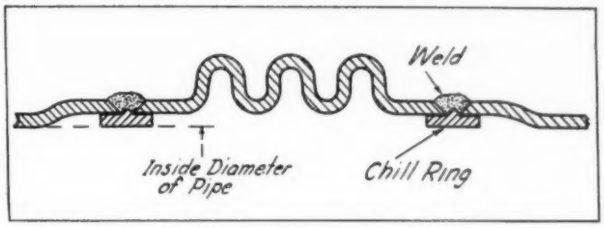


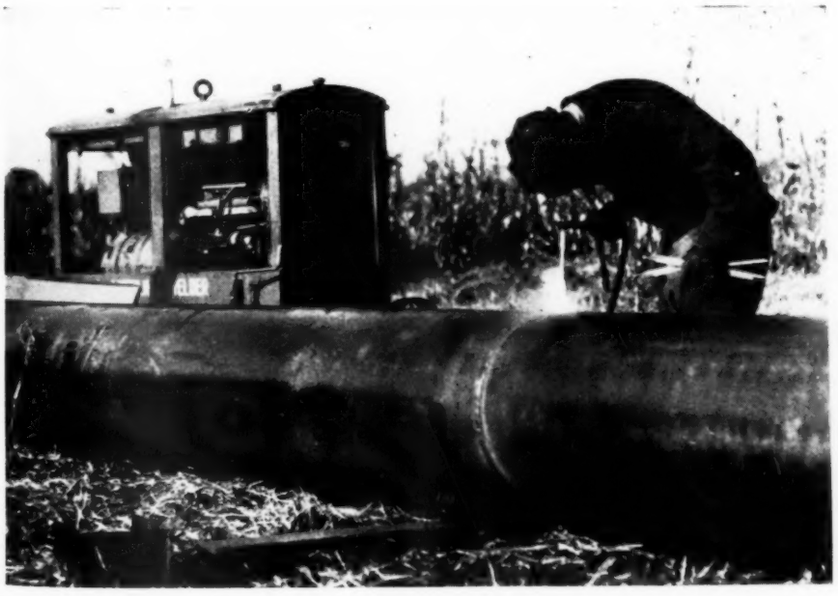
Figure 5: The "wrinkle" type expansion joint

The wrinkle type of expansion joint for welded lines is still popular, but an improvement has been made in its construction. Outwardly, the joint has the same appearance as the old type of wrinkle expansion joint, but, as can be seen in Fig. 5, the sliding sleeve that formerly extended beneath the wrinkles has been eliminated. Two butt welds with chill rings are now made with the bell ends of the pipe and the process of welding is the same for each weld as in the straight pipe. For gas welded lines, the weld is, of course, made with the dished liner and 65-degree bevel in the same manner as described for the oxy-acetylene welding of the gas welded double bell joint.

A method for making actual tensile tests in the field has been used for about a year by one company supervising construction of oxy-acetylene lines. A test car is used for this purpose and gives the result of the test at once and right where the coupon is cut out. The delay caused by sending the coupon to a laboratory is thus eliminated and any poor workmanship can be discovered before much bad welding can result.

This portable field tester is mounted on a light truck and includes a cutting and welding outfit as well as a machine for testing the tensile strength of a coupon. The inspector cuts a coupon from any weld he selects and places it in the machine. Force is applied by hand-pumped hydraulic power and the exact tensile strength that is exerted on the piece is shown on a gauge. Each coupon is tested to destruction; and if the weld shows a satisfactory tensile strength a piece of pipe is cut and fitted to the opening left by the coupon and then welded in. Welds made by either the gas or arc method should equal or exceed the strength of the pipe itself, and while tests of coupons may not be an absolute sure way of discovering bad welding jobs, they will do much to make the welding crew maintain the quality of work which is necessary for a satisfactorily welded line.

The use of the latest design in joints does not preclude the necessity of using ingenuity in pipe line construction. In an accompanying illustration is shown a bell and spigot joint that had to be made on a line using double bell joints.



Pipe on rollers to make it easier to turn while welding.

Successful Repressuring of Nowata Field an Economic Operating Problem

By WARREN L. BAKER

THE recovery, or partial recovery, of the oil supply remaining in oil sands after the usual methods of production have become unprofitable is one of the greatest problems in the petroleum industry today. It is a recognized fact that only a very small percentage of the oil is being recovered from known reserves, and that the old, shallow fields represent a tremendous oil supply, when, and if, profit-yielding methods are developed to recover the known oil remaining in the producing horizons.

Various methods have been used and many others proposed for the increase of ultimate oil recovery from normally depleted sands. Oil sands are being mined by means of shafts and galleries in several foreign countries. In other places, notably the Bradford, Pa., field, the ultimate yield has been increased by means of water flooding, wherein water is introduced into the sand to displace oil and thus drive it to the producing wells. Vacuum has been used extensively in Eastern and Mid-Continent fields for the purpose of stimulating production. The compressed air or gas process of repressuring has been widely and successfully used in many areas.

The Nowata district, representing all of Nowata and Rogers counties in Northeastern Oklahoma, is an outstanding example of a large region that has been rejuvenated by the application of repressuring practices to the extent that many of the properties are being operated at profitable returns despite present low crude prices.

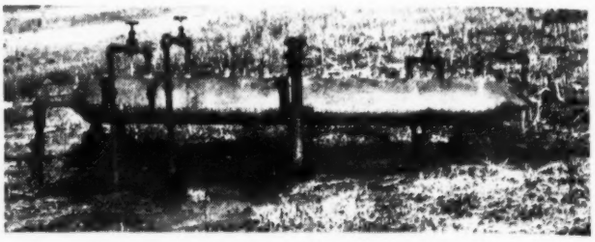
Following is a table of production figures showing the output by years of Nowata and Rogers counties since 1925:

1925	2,067,785 Barrels
1926	2,358,655 Barrels
1927	2,364,795 Barrels
1928	2,717,425 Barrels
1929	2,724,400 Barrels
1930	2,749,335 Barrels
1931	2,353,865 Barrels

During the year 1931, no effort was made by operators to increase production; rather the drop in output may be contributed to efforts on the part of several companies and individuals to lower their daily recovery. Figures for the year 1932 are not yet available, but they no doubt will show a further decline, as a large part of the field was completely shut down during the early part of the year.

General view of small repressuring compressor station

It is exceedingly interesting that from the year 1925 through 1930, production had been increased slightly more than 36 per cent for the entire territory, despite the fact the area was not 100 per cent under repressure and that the majority of compressor plants were not of sufficient capacity



Header on field distribution system. Note the one-inch connections

to return full benefits. At the same time it must be remembered these production figures include the smaller properties as well as those more successfully repressured. In many individual cases, leases showed production increases of several hundred per cent.

Repressuring has been going on in the Nowata district actively since 1925, at which time the wells had been producing from twelve to twenty years. The first major application of pressure to oil sands in the Mid-Continent was in this region in the spring of 1924. Two years later 80 plants were operating in the state, the majority of which were in the Nowata field. Since this time the Nowata territory has been constantly repressured, and increased results have been obtained annually up to 1931.

It is likely that the peak output of the region has been reached, but it is expected to show a very small decline curve from this time on. It is this anticipated steadiness of production that is a large factor in making the scarcity of leases for sale; with production already on a settled basis it is not difficult to figure actual returns in barrels that a lease will produce over a period of several years. The majority of leases are now paid out, or soon will be (including repressuring expenditures), and operators expect to receive a very nice, steady income in the future. It has often been said that the old, settled producing leases are the backbone of the oil industry and this statement still remains true today despite our unusually large flush producing fields of the past five years.

The recovery of this oil is primarily an economic problem. Under present prevailing crude prices, the first consideration is for methods that return profits to the operator with only low operating expenditures.

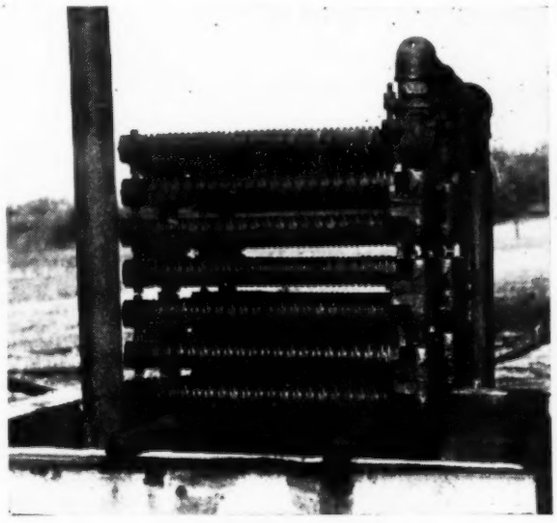
Increases in production have been satisfactory in many cases, but what has been

more encouraging, many operators have found repressuring a means of decreasing production costs. Operators of this district are at present more interested in reducing costs than quantity of the oil recovery in the sand. Many of the better engineering principles have been deferred because of the expense required to install equipment and change to different hook-ups, etc.

Because of the necessity of keeping within the revenue return limits of each lease, the majority of present compressor plants are single unit types that are either gas or steam engine driven single or double stage compressors. For safety purposes, the majority of the compressors are of larger capacity than generally needed for the amount of pressure they are handling.

The operators have found that compressor plants and other producing equipment must be built to operate with a minimum amount of attention. Practically all of the compressor buildings are of the portable galvanized sheet iron structural type with concrete floors. This type of building is permanent and reduces the fire hazard to the point that it is not necessary to carry fire insurance.

A number of operators are now using concrete cooling pits instead of wooden tanks. For economy, these pits are concreted only on the sides, and the bottoms are of clay. It has been found that this type of water receptacle has a greater cooling surface and requires less upkeep expense.



Close-up picture of radiator coils in use as coolers between low and high stages of compressors

Because of the necessity for keeping expenses very low and have as near automatic operation as possible, several operators have contrived mechanical devices to aid them. For instance, the home-made water bucket type of shut-down system for the compressor prime movers is quite common. This system consists of placing a leaky bucket in such a position over the cooling water tank or pit that the returning water must fill the bucket. The bucket is connected by a small wire running through pulleys to a counterweight. Whenever the water supply fails, due to a breakdown in the circulating pump, the water in the bucket leaks out and since there is no new water then available to refill the bucket its lighter weight allows the counter-weight to fall, which action operates the control arm on the gas intake to the engine. In this fashion, any serious damage due to lack of circulating water is automatically prevented and it is not necesary for the pumper to be at the plant as constantly as it would otherwise.

Gas is very scarce in the district, therefore air is commonly injected into the sand for repressuring purposes. At the time repressuring activities were started, the region had no gas but sufficient gas is now being produced on most of the leases to operate the power and compressor prime movers. On some of the leases enough gas is now being produced that small quantities may be recycled into the repressuring stems and a mixture of air and gas is being used. It is therefore quite important that adequate cooling systems be provided to cool the mixture between the high and low stages of the two-stage compressors. Small size pipes are very frequently welded onto racks to act as aerator towers, but air-cooled radiator sections are also used. The latter have proved very satisfactory and in most cases do not require that water be run over the outer surfaces to give greater cooling means. The radiator coils are very convenient in that they do not take up as much space and may be placed over the water tank or pit so that water may be circulated over them when desired.

It is also very important that the input fluid be quite dry, therefore drips are installed on all of the properties. Some plants have both an upright drip and a horizontal header. Some of the operators have carried their economy efforts to the point that the headers are equipped with one-inch outlet connections, instead of two-inch, as is the intake. This saves considerable money in installing and replacing and the short distance through the small connections is not sufficient to make much difference in the passage of the fluid.

Because of the use of air and gas mixtures on several leases, operators have placed the starting tank outside of the building. This is indeed a wise practice from a safety standpoint.

A few of the wells in the region are flowing naturally as the result of repressuring, but still practically all of the thousands of wells represented are dependent upon the pumping jack to lift the oil to the surface. At this time the wells are pumped but a few hours each week. This practice is partly due to the very low recovery of the wells and partly to operators attempting to reduce pumping time.

Water flooding is now being tested with encouraging results in the district, but it is too early in the experiment to know whether the increased production will continue over a period of time long enough to pay profits.

A leaky bucket automatic shutdown system at Nowata compressor station

Application of Equitable Proration to Fl

By K. C. SCLAT

New Production Practices Evolved From Bottom-Hole Pressure Investigations in East Texas Field

WERE the problem of prorating a flush field of diversified ownership a purely technical one, its solution could be greatly simplified. Many extraneous factors enter into the problem, however. Men of technical training when faced with the task of working out a practical and equitable plan of proration find themselves confronted with a mass of legal and economic considerations that are difficult to reconcile with the technical aspects of the problem. To this fact can be attributed, in large part, the confusion and obstacles that have arisen in regard to proration.

To reconcile these conflicting phases of the problem, legal assistance has been necessary. In settling the differences the lawyer is, or should be, guided by the available technical data bearing on questions in dispute, for these form the groundwork for the formulation of any proration plan proposed. Occasionally the difficulties become so great that at times it would seem as though the legal phases of the proration problem far transcend in importance all other factors. Revision of state and federal statutes is expected to aid greatly in correcting this condition.

When first adopted in the Mid-Continent fields several years ago, proration was considered an expedient to tide over a temporary situation. Equities were worked out on an arbitrary basis with little thought given to the existing reservoir conditions. Today, proration is looked upon as an essential requirement for efficient and orderly production, hence arbitrary methods of oil field proration are rapidly being discarded in favor of methods based on sound principles of oil production. Arbitrary methods were all right so long as no feasible plan based on engineering principles was available, but in the light of recent progress in the practical application of advanced technical skill and knowledge to the analysis of reservoir and individual well conditions under routine producing operations, the adoption of a strictly arbitrary plan of proration seems almost inexcusable.

Practically all proration methods that have been in use have had potential production as a dominant factor on which to base allowable production. As usually determined in the field the capacity or potential production of an oil well is vague and meaningless, and it is unfortunate indeed that so much store has been laid by such fictitious measurements for determining the capacity of a pool or an individual well for purposes of proration. The inequalities that can enter into potential production determinations has been discussed in a series[1] of three articles published about two years ago.

During the time proration has been in effect, oil field practices have undergone a vast change, especially those practices pertaining to the development of flush fields. Much has been learned about reservoir conditions through coring, core analysis and the taking of other pertinent sub-surface data. Also a new conception has been gained regarding the rights of the various property owners in a pool to share in the oil, gas and gas energy and this, together with the rapidly accumulating knowledge renders more remote the possibility of a return to the old destructive competitive conditions in the development of new fields.

It is now a well established fact that in a pool the production from which is withdrawn under some method of control, the maximum benefits to be gained by the operators in the field as a whole are dependent on the scrupulous observance of certain sound principles of production especially applicable to that pool.

In a field of diversified ownership one of the big problems that must be solved is that pertaining to drainage across property lines. The drilling of offset wells is the remedy usually resorted to to counteract this condition. More often than not, when this procedure is followed it disregards entirely the sub-surface and reservoir conditions. The drainage problem is one that is the very root of almost all the troubles that arise when questions of equity are in dispute. Therein is where the technical aspects of the proration problem encounter extraneous factors that are entirely outside the realm of oil production practice but which nevertheless must be taken into consideration. Where no uniform spacing plan has been followed and where there are a large number of small tracts in the field, it occasionally becomes necessary to sacrifice the best interests of the majority of operators in the pool by modifying the plan of operation.

It is the sole object of all responsible producers to obtain the greatest ultimate recovery of oil from their properties at the lowest unit cost per barrel. This is the goal of all efficient operators and is the goal sought and striven for by the technical staffs of all oil companies. Assuming, therefore, that each operator in a pool is entitled only to the oil, gas and gas energy underlying his tract and that he assumes that as his right and also recognizes and respects similar rights of all other operators in the pool, certain uniform production practices must be followed if each operator is to obtain his just share of the contents of the pool. These practices obviously must take into account the reservoir conditions and permit each producer to develop his leases in such manner as he sees fit to obtain the greatest ultimate recovery of oil at the lowest cost per barrel without injuring the rights of other operators in the pool.

To follow out a plan that would accomplish this in a field of diversified ownership is not always possible. It is necessary to know within a reasonable degree of accuracy what the underground conditions are very early in the development of the field, for on this information will depend the minimum

[1] *The Petroleum Engineer*, Jan., 1931, p. 26; Feb., 1931, p. 31; April, 1931, p. 96.

to Flush Fields Has Perplexing Angles

SCLATER

Closer Determination of Reservoir Conditions and Well-Spacing Are Important Phases of Proration

economical well-spacing that should be set for the field. To set such a minimum economical well-spacing early in the life of the field before too much development is under way it is necessary to have information on the thickness of the pay sand, data indicating the permeability, oil and gas content and the nature of association of the oil and gas in the sand, reservoir pressure, presence or absence of water and hydrostatic pressure. Such data must be obtained from the first wells drilled in the field.

There are inherent difficulties about obtaining this information. It is only recently that instruments have been developed and put into practical use for the taking of sub-surface pressures. Notable progress has been made in the East Texas field in this newly-developed phase of oil field production practice.

The gathering of sub-surface information comprises the analysis of sub-surface or bottom-hole pressure data for the investigation of sand conditions. Sub-surface pressure readings taken in wells under static and flow conditions, it has been found, convey valuable information on the physical character of the reservoir. Technique in obtaining and applying this information is one of the most important advancements that have been made in the application of science to the production of oil. Many of the perplexing problems encountered in applying equitable methods of proration will eventually be solved by means of sub-surface data. Such data lend themselves peculiarly adaptable to the solution of sub-surface problems.

It is now possible by means of sub-surface pressure readings taken while a well is flowing to gauge the productive capacity of the well and also observe its flowing characteristics. Investigation of these flow data of wells in the East Texas field show, or rather indicate, that the permeability of the pay sand varies widely in different parts of the field and that the ability of wells to produce is affected accordingly.

Pressure gradients obtained in wells from sub-surface pressure readings taken under static conditions have revealed that some wells in the East Texas field actually have a few hundred feet of water standing in the bottom of the hole and still produce oil without showing a trace of water. With the low per-well allowable that obtains in the field most of the wells are opened up for only a few hours daily, just long enough to produce the daily allowable. The fluid level in these wells is high and a column of oil in excess of the daily withdrawal stands in the tubing above the water. As the well is open only a relatively short time daily, it seems that it is shut in long enough each day to allow the oil to flow into the well and pass up through the water standing in the hole. From this it can be seen that it is possible for a well to be making a little water and still show no evidence of it when the well is produced. Information of this nature is pertinent to a study of underground conditions and is closely related to the problem of proration in the field.

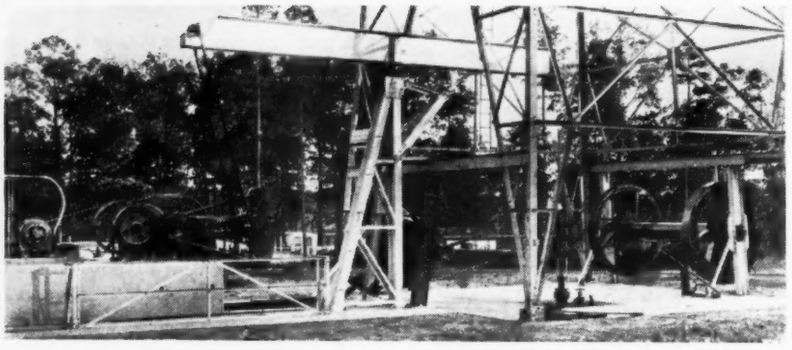
From a technical standpoint, the setting of an economical well-spacing for a flush field is no easy problem. Meager information regarding the physical conditions in the reservoir has been the greatest obstacle in attacking the well-spacing problem. Heretofore, it has been found that even when the necessary data on reservoir conditions are available, there are difficulties that arise in interpreting the combined effect of the various factors that influence the flow of oil to the hole. Although a vast amount of laboratory investigation on this problem has been assiduously pursued, not enough information has yet been obtained of the kind that can be applied directly to practical well-spacing problems of the type usually encountered in actual field practice. The sand and physical conditions in a reservoir are so variable and the difficulty of obtaining suitable field data so great that the problem of determining an economical well-spacing in a flush field is one of the most complicated problems confronting the industry today.

So far as the reservoir conditions are concerned, and if the well-spacing is to be based on these conditions, it is quite possible that the optimum well-spacing is not the same for all parts of the field. For example, the thickness of the sand may be several times as thick in one part of the pool as in another part. Even assuming that the permeability is uniform, which it rarely is, a closer spacing would be justified in the areas of greatest sand thickness. Added to these variable conditions are the variation in saturation and the presence of bottom or edge water.

Permeable streaks in a sand stratum are a problem where water is present. Water will encroach at a much greater rate in the more permeable sand and thus give rise to uneven encroachment or fingering in, thus trapping off some of the oil in the sand. It is quite likely that water encroachment of this nature will be encountered in the East Texas field.

There are factors other than reservoir or sand conditions that enter into the spacing problem. One of these is the market price of oil. This is an economic factor and a very important one in well-spacing. As the life of the average field extends over a period of from fifteen to twenty years, the prevailing price of oil during that time has to be taken into account. It is to be noted also that the deeper the producing horizon the more important this item of price becomes in the well-spacing problem.

Engineers are now devoting a lot of thought to the practical phases of well-spacing for it looms as one of the most important that will have to be solved in the coming years.

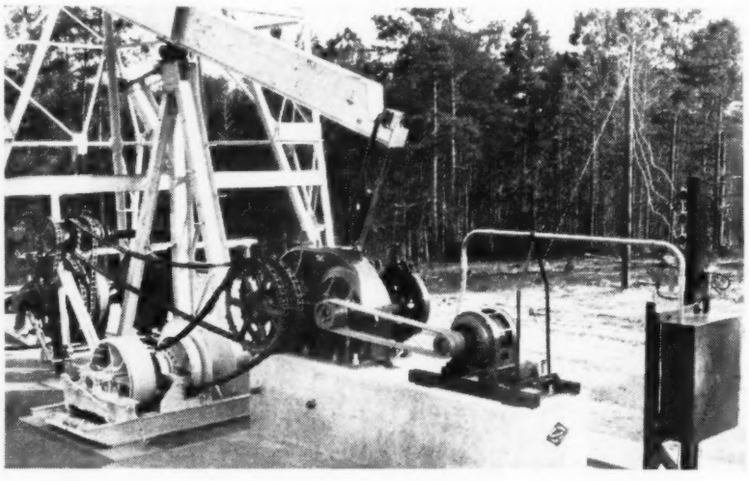


Overall view of a Superior Oil Company of California rig, with single-brake production hoist and bull wheels.

Wells Equipped for Pumping in East Te

MANY operators in the East Texas field are anticipating their pumping needs and giving deliberate consideration to the surface machinery requirements best adapted to meet the particular conditions under which the wells will probably be produced. In this connection, one of the most interesting of the developments to date is that of the Superior Oil Company of California. This company has recently completed the installation of pumping machinery on 28 of its wells in the field. In addition, definite plans have been made for seven more identical installations and tentative plans for several additional jobs.

All installations made thus far have exactly the same equipment with the same setting except two, which, due to their low location, necessitating protection against high water, are set on combination steel and concrete substructures. The installation of this equipment carried on under Superior Oil Company's supervision, is representative of the exceptional care and planning on the part of many companies today, since they realize that equipment well installed operates with lower maintenance expense and the production men manifest greater interest in its proper care.



Overall picture of sand reel, hoist and rotary machine drive. Note Universal motor slide rails, permitting application of heavy drilling motor.

Although most of the equipment is of conventional design, there are some rather unique ideas incorporated in both the design and hookup of some of it that will be of interest to a great many operators, especially since several new methods of meeting the requirements of a pumping and servicing rig have been worked out.

Equipment Installed on Each Well

Emsco-Falk No. 11 MDS double reduction gear unit equipped with flywheel, brake, hoist driving sprocket and Emsco crank counter-balance with extra weights and with taper fit wrist pin.

Emsco Universal motor slide rails to accommodate any type of motor, including large variable speed cleaning out motors.

Emsco 46-inch stationary type production hoist with single brake and with high mounted drum with drum shaft extended to accommodate clutch rotary machine driving sprocket or clutch tug wheel for bull wheel drive with jack posts drilled for lineshaft boxes.

Emsco derrick appurtenances, including: Type No. 23045 galvanized Samson post; Type No. 110-WS straight-lift type walking beam; Type No. 200-W fully enclosed dust-proof oil bath center irons; Type FA-4 pitman with fully enclosed self-aligning wrist pin bearing; hoist headboard and hoist post braces; counterbalance guard rails.

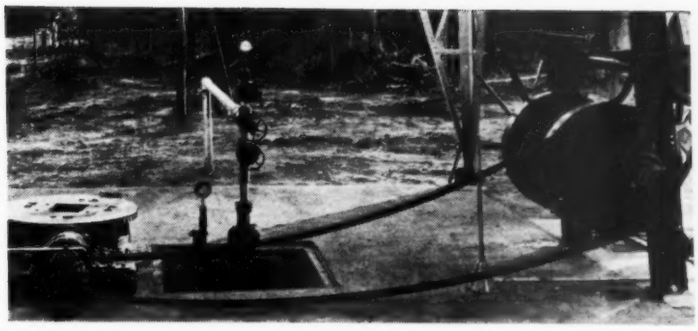
Although the motors, controllers and V-belt drives have not been installed as yet, installation of General Electric 15-25-40 hp. 1200-1200-1200 r.p.m. Y-delta internal delta triple rated constant speed induction motors is contemplated.

To understand the different provisions that have been worked out to take care of the various duties of pumping, pulling rods and tubing, cleaning out or drilling deeper with cable tools or rotary, it will be advisable to take each operation separately.

Pumping

As appears probable at this time, the field will be produced under restricted well allowables for some time. Much thought has therefore been given to the most economical method of pumping. Recognizing the desirability of holding the demand charge to a minimum, it has been felt by the operator that slow-speed pumping using the minimum possible horsepower requirements over a 24-hour period presented the most economical method of operation.

For this reason the triple-rated motor has secured favorable consideration, operating as it does at high efficiency and with a thoroughly adequate power factor at any of its ratings. It is the present plan to install V-belt drives with a ratio to give



Rotary machine drive from two-speed line shaft, double-brake type hoist.

ast Texas to Meet Future Producing Demands

nine strokes per minute. At this pumping speed the motor would be connected on the 15-hp. side.

In case a different speed is desired, a single change of one of the V-belt sheaves accomplishes it. In the event of heavier pumping loads that might be encountered later, due to raising of the allowable or to water encroachment, the motor can, if necessary, be connected on the 25-hp. side or under possible extreme condition on the 40-hp. side, but the 40-hp. top rated motor was selected primarily to meet the horsepower requirements of pulling rods and tubing rather than with the expectancy that such a rating would be required for pumping.

Pulling Rods and Tubing

Feeling that it is desirable on its leases, the Superior Oil Company has equipped every well with a production hoist so that each is self-servicing. These hoists are of the single-brake type with two speeds available by having a double sprocket clutch and shifting the driving chain from the larger to the smaller sprocket or vice versa.

The hoists are mounted permanently in the derricks with steel jack posts and steel headboards, and have been designed with proper brake, line and horsepower capacity for service in the East Texas field.

V-belt drives have been worked out to accomplish a crank speed of 30 r.p.m. for pulling on the 40-hp. motor connection. This has been accomplished by mounting a permanent hub on the high-speed unit shaft to which can be readily attached a 7-groove 12-in. PD sheave for pulling or a 3-groove 40-in. PD sheave for pumping at 9 s.p.m. The motor will be equipped with a 7-groove 9-in. PD sheave only, three belts being utilized for pumping, while seven are used for pulling. Two or three of the unit pulling sheaves and extra sets of ropes would be carried as rod gang tools.

Rotary Cleaning Out or Deepening

One of the unique features of these production hoists is the manner in which they can be readily transformed into light drawworks with rotary machine drive. The jack posts of each hoist are drilled for line-shaft boxes.

When it is necessary to clean out with rotary tools, a double-brake drum is substituted for the single-brake drum and a lineshaft is bolted in place. The design is such that this is accomplished readily and quickly.

The chain drive from the gear unit is then to the hoist lineshaft, and two selective hoisting speeds are available by clutching. The drum shaft is equipped with a rotary drive sprocket and this drive combination, with the Emsco D rotary machine equipped with a quill type clutch sprocket, completes the rotary lineup. Separate slush pump units would be provided.

One lineshaft, double brake drum with drum shaft and the rotary machine, are all that is needed to convert these outfits to rotary clean-out or drilling-in rigs. The double-brake drum has sufficient line, brake and horsepower capacity to handle the required amount of drill pipe for the East Texas area.

A heavier variable speed motor may be substituted for the pumping and pulling motor, mounted on the Universal motor slide rails, and a V-belt drive of greater horsepower capacity could be substituted for the pumping and pulling drive.

Cable Tool Cleaning Out or Deepening

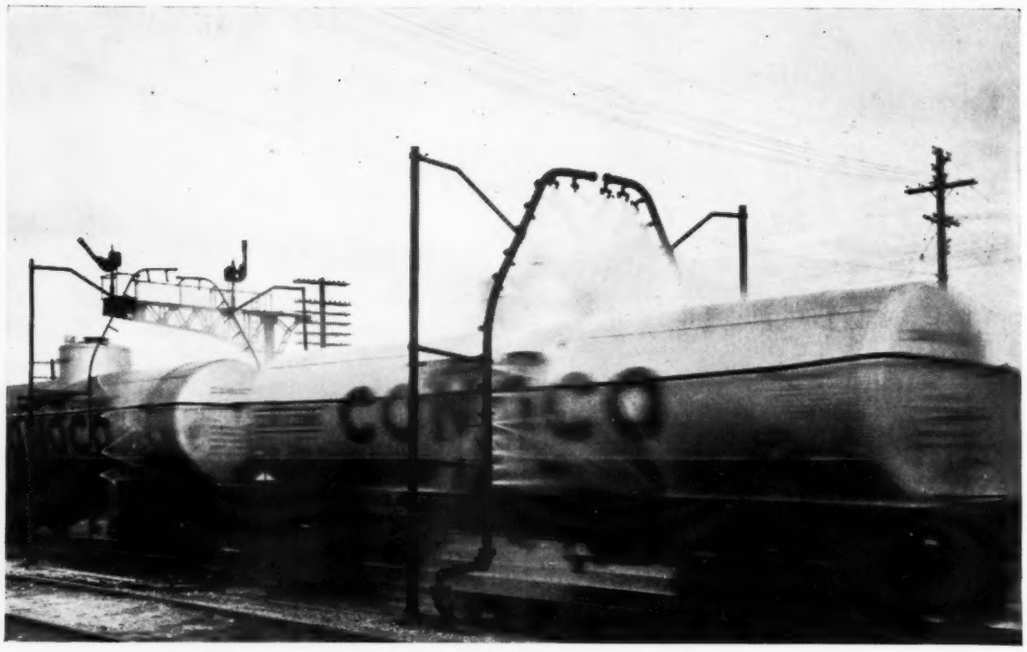
In case cleaning out or drilling deeper is preferably done with cable tools instead of rotary tools, this equipment is as readily adapted to that method as it is to the rotary method. A clutch tug wheel is mounted on the extended hoist drum shaft and a set of bull wheels installed.

The gear unit chain drives the hoist drum shaft, and regular bull-rope drive is used from there to the bull wheels. While the bull-rope drive centers are approximately 24 ft. instead of the usual approximately 36 ft., this shorter center is compensated for in part by the greater arc of contact of the bull ropes on the tug and bull wheels. The wear on the bull rope occasioned by the ropes rubbing together is largely eliminated by the tilt of the tug wheel mounted on the tilted production hoist shaft, greatly reducing the pressure of the ropes upon each other.

A sand reel is mounted between the gear unit and the production hoist, and is chain-driven from a second sprocket on the rear of the crankshaft of the gear unit. This sand reel can also be used if desired for bailing with the rotary lineup.

As in the case of rotary clean out, a heavier variable speed motor with heavier V-belt drive is substituted for the pumping and pulling motor and drive.

At first thought the great adaptability of this type of rig would seem to indicate excessive cost, but a careful study of the various applications proves they are more economical in the long run and indicative of what may be accomplished when the stress of economic or changing conditions in the industry force the oil producer and equipment manufacturer to give real study to today's producing problems.



Tank Car Cleaning Apparatus used by Continental Oil Company

Specially Designed Rack Cleans Five Tank Cars a Minute

TO obtain the greatest advertising value possible from its aluminum painted gasoline tank cars as well as its black lubricating oil cars, the Continental Oil Company, Ponca City, Okla., has developed an unusually efficient method of tank car cleaning. By means of the method the several hundred cars constantly passing through the Ponca City refinery are cleaned at least once every three months. Conducted through a new and specially designed cleaning rack at the rate of five per minute, the cars emerge with their original finish so successfully restored that they actually appear to be newly painted.

The cleaning rack trackage, located within the refinery grounds, is provided with an efficient drainage system. The rack itself comprises two pairs of upright arched headers or standpipes equipped with nozzles. A special cleaning solution is sprayed over the tanks by one pair of headers and then washed off with clear water under pressure by a second set. When not in use both sets of headers are swung clear of the track in order to prevent their being damaged or blocking the track.

The headers come upright from below ground connections. They are arched at the top so that they conform to the circular shape of the top half of the cars. The nozzles are adjusted to give the maximum surface coverage as liquid is being sprayed from them. Pumping equipment used in connection with the rack is located in an adjacent building.

The headers for the chemical cleaning solution are made from one-inch pipe with 12 nozzles on each header. The chemical cleaning agent contains caustic soda and trisodium. It is mixed with water in a tank about 36 inches in diameter and 48 inches deep. The solution contains approximately one-half pound of chemical per five gallons of water and is agitated by means of a steam line. A rotary pump driven by a 10-hp. motor sprays the solution on the tank at a nozzle pressure of 90 pounds. The cleaning solution comes out in a fine spray and a quantity of five gallons of solution is required per car.

The water header is made of three-inch pipe. In design it is identical to the header used for the spraying of the chemical except that it is equipped with 13 double nozzles. The water is shot through the nozzles at the rate of 650 g.p.m., and with a nozzle pressure of 125 pounds. The water header is operated by a 650 g.p.m. centrifugal pump driven by a 60-hp. motor. A 15,000-gallon auxiliary tank has been installed in connection with the water spray system to insure a constant supply of liquid at all times.

In operation a string of dirty tank cars is slowly moved through the spray cleaning solution and water bath. The cars are conducted over the rack at the rate of one every 12 seconds.

In order to guard against the cleaning solution attacking the paint a large number of experiments were necessary before the proper timing was found. The two sets of nozzles are approximately 22 feet apart and, if too long an interval is allowed between the application of the cleaning solution and the high-pressure water bath, the chemicals in the solution will attack the paint.

The spacing of the nozzles and their adjustment presented a tedious problem. They are so spaced that a uniform application of cleaning solution is sprayed over the entire tank, even as low as the bottom sheets. A similar adjustment was made for the high-pressure clear water nozzle.

The aluminum painted cars are used to transport gasoline, distillate and kerosene. Cars painted black are used to transport fuel and lube oil and are cleaned by hand after loading. One man sprays the cleaning solution on the car while another washes it off by means of a hose line.

A further use for the cleaning rack is found when the cars are to be cleaned preparatory to painting. Ordinarily the cars are painted once every two and a half years.

Perforation Cleaner » » » » »
Designed to Revive Weak Wells

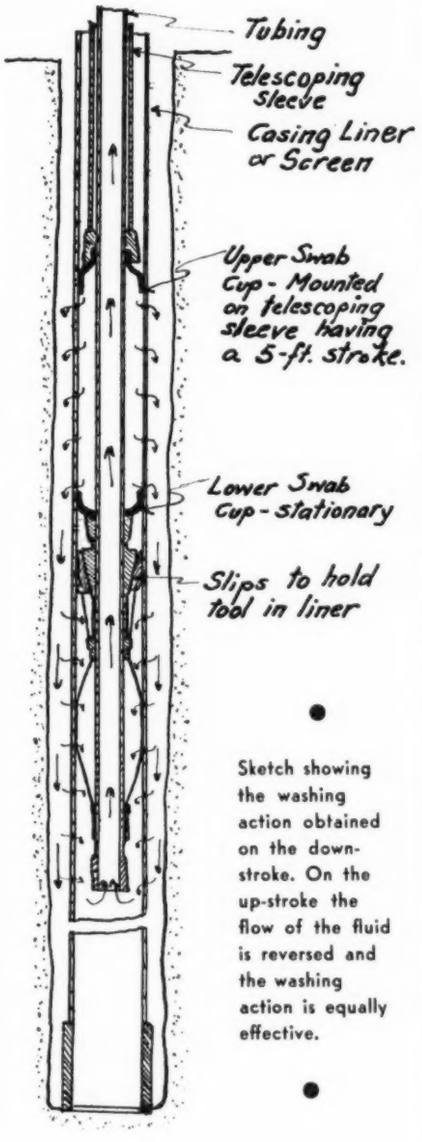
IT is far more common than is generally supposed for a producing well with perforated liner to lose its kick and fall off in production to only a fraction of its possible capacity because of clogged perforations. Trouble of this kind in a well is usually so obscure as to make it difficult to diagnose, with the result that often an expensive remedial job, necessitating pulling of the liner and cleaning out, is resorted to in an effort to bring the well back.

More often the well is allowed to produce without the real source of the trouble ever being suspected. If the well drops gradually in production, as it usually does when the liner perforations become clogged, it is sometimes attributed to depletion of the pay sand.

Trouble from clogged liner perforations can be successfully combatted by the use of a perforation cleaner. For this purpose the Howco perforation cleaner, especially designed to revive weak wells, has recently been introduced into the Mid-Continent and Gulf Coast fields by the Halliburton Oil Well Cementing Company, which services the tool. This device has been in successful use in California for some time.

It is run in the well on tubing or drill pipe. After being lowered into the perforated liner or screen it is set with the tubing catcher at the desired point.

To operate the tool the tubing or drill pipe is raised and lowered through the 5-ft. stroke, the length of the telescoping arrangement. This movement causes the fluid to surge in and out of the perforations in the space between the swab caps. As can be observed, the pumping motion of the upper swab sets up a differential pressure between the inside and the outside of the liner in the 5-ft. space between the swab cap, the velocity of the fluid dislodging and removing the substances clogging the screen or liner perforations.


Tubing
Telescoping Sleeve
Casing Liner or Screen
Upper Swab Cup - Mounted on telescoping sleeve having a 5-ft. stroke.
Lower Swab Cup - Stationary
Slips to hold tool in liner

Sketch showing the washing action obtained on the down-stroke. On the up-stroke the flow of the fluid is reversed and the washing action is equally effective.

After the perforations in a 5-ft. interval are cleaned, the device is reset at the adjacent 5-ft. interval, above or below, and the operation repeated. This is continued until the whole length of perforated liner or screen has been treated.

It will be noted that the device operates on a pressure equal to the hydrostatic head of the well fluid level and without circulation from the surface. This is a very desirable feature as it removes the hazard of putting a hydrostatic head on the face of the producing sand in excess of the well's natural fluid level. It is possible to do irreparable damage to a well by clogging the face of the sand through applying a pressure that is in excess of the natural bottom-hole pressure.

The weight of the tubing or drill pipe is used on the down-stroke to impart the surging motion to the fluid.

By the same means the pressure inside the liner between the swab caps is always under complete control. This is a valuable feature when a well, the liner of which has been weakened by corrosion, is being treated.

In the accompanying sketch the effective washing action of the fluid on the perforations during the down-stroke of the tool is indicated. On the up-stroke the flow of the fluid through the perforations is reversed. This surging motion imparted to the fluid ensures the thorough cleaning of the perforations.

Simple and effective in operation, the perforation cleaner is designed to increase the production of weak wells at the lowest washing cost. There is an absence of complicated parts and the necessity for pumps at the surface is eliminated.

With a device of this kind available for instant use, wells that are prone to give trouble due to clogging of the liner or screen perforations can be made to maintain their highest producing efficiency with a minimum of shutdown time.

The Behavior of Occluded Gas in an Oil Sand Reservoir

By IONEL I. GARDESCU,☆ Ph.D., Petroleum Engineer and Geologist

PART III.
An Analytical Study of the Resistance Offered by Occluded Gas

IT has been shown in the preceding article that the surface tension forces along a curved interface exert a pressure in the direction of curvature and that as the radius of curvature diminishes, the excess pressure becomes greater. The excess pressure may be found by the use of the following formula:

$$p = pi - po = \frac{2T}{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

p = excess or differential pressure
pi = inside pressure of a gas bubble
po = outside pressure
T = surface tension force of gas-oil interface
R = radius of curvature.

Gas bubbles have before been shown to be unable to move freely from one sand pore to another because of their size, which is ordinarily larger than that of interporous openings. The size of the interporous openings is here expressed in terms of the radius *r* of the largest spherical bubble that may be forced undistorted from one pore space into another.

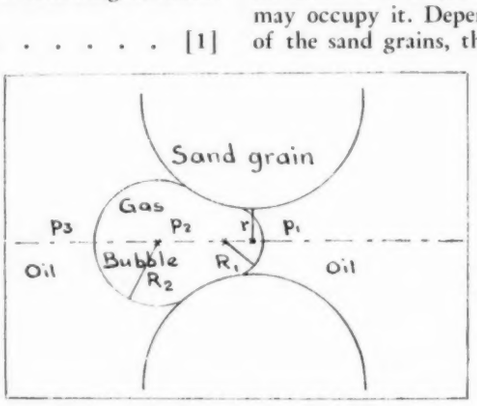


Figure 9: Distribution of gas bubble

In order to move through an interporous opening, an ordinary gas bubble must stand distortion in a manner somewhat similar to that illustrated by Fig. 9. Applying equation [1], the differential pressure P, exerted against the bubble and causing distortion, is obtained:[1]

$$p_2 - p_1 = \frac{2T}{R_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

$$p_2 - p_3 = \frac{2T}{R_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

Eliminating p_2 between equations [2] and [3]:

$$p = p_3 - p_1 = 2T\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad . \quad . \quad [4]$$

p_2 = inside pressure of the gas bubble
p_1 = outside pressure along interface of R_1 curvature
p_3 = outside pressure along interface of R_2 curvature
P = differential pressure causing distortion and eventually displacement of bubble.

It is readily observed from equation [4] that P reaches its maximum value when R_1 is minimum or equal to *r*, the radius of the interporous opening.

There is a certain geometrical relationship in a sand reservoir between the value of *r*, the two radii of curvature R_1 and R_2 of the distorted gas bubble and the size of the pore space, which may be expressed, as in the case of the interporous opening, in terms of a radius R of the largest possible sphere which may occupy it. Depending on the arrangement and sorting of the sand grains, the minimum value of R_1 equal to *r*, is 0.3R to 0.5R. When R_1 is minimum, R_2 assumes a definite value depending on the size of the bubble. Thus, for the largest possible bubble, which is of radius R, the corresponding value of R_2 is 0.7R.

An average maximum value of P may be obtained by substituting in equation [4] the average values of 0.4R for R_1 and 0.6R for R_2.

$$P = 2T\left[\frac{1}{0.4R} - \frac{1}{0.6R}\right] = \frac{T}{0.6R} \quad [5]$$

P is estimated to be 600 dynes per square centimeter, or 0.0006 atmosphere by substituting in equation [5] the values 3 = 0.05 cm. (corresponding to 20 mesh sand), and T = 18 dynes per cm.

This differential pressure of 0.0006 atmosphere will be used in analyzing the distribution of pressures and the rates of flow in the immediate vicinity of a gas bubble.

Fig. 10 shows a small portion of the reservoir in which oil occupies every pore space excepting pore space *a*, which is occupied by a gas bubble. This gas bubble was formed at a selective point following the drop in pressure brought about by the tapping for production. The total volume occupied by free gas in a reservoir does not exceed the volume of produced oil which represents only a small percentage of total available oil. Thus only a small number of the pore spaces are occupied by gas bubbles.

In order to displace one of these gas bubbles, a differential pressure of 0.0006 atmosphere must exist, when the figures above are assumed. The differential pressure between pores *a* and *b* (Fig. 10) will cause the oil that filled the surrounding unobstructed pores to flow in the direction of least pressure. This rate of flow can be readily calculated by the use of Poiseuille's formula:

$$Q = \frac{TT(2M)^4 P}{8LU} \quad . \quad . \quad [6]$$

P = 600, differential pressure in dynes per sq. cm.
M = 0.0005 cm. mean hydraulic radius of the interporous opening calculated from the formula $M = \frac{\text{area}}{\text{circumference}}$

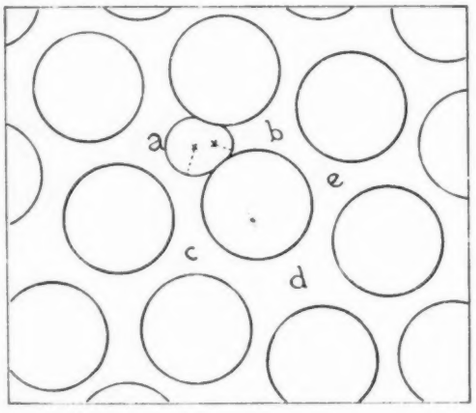


Figure 10: Gas bubble in a sand reservoir

☆ Professor of Petroleum Engineering, University of Pittsburgh.

[1]Gardescu, I. I. Behavior of Gas Bubbles in Capillary Spaces. A.I.M.E. Petroleum Development and Technology, 1930, pp. 351-370.

$L = 0.07$ cm., assumed length of interporous passage equal to diameter of sand grain calculated from $R = 0.05$ cm.

$U = 0.06$ poises, viscosity of oil.

substituting in equation [6]:

$$Q = \frac{3.14 \times (.01)^4 \times 6000}{8 \times .07 \times .06} = 5.6\ 10^{-4} \text{cc. per second.}$$

Dividing Q by the cross-sectional area (0.00865 sq. cm.) of the interporous opening, the velocity of flow is calculated to be 0.065 cm. per second. The total rate of flow of oil through a reservoir towards a well is the product of the velocity of flow and the cross sectional area through which the flow takes place. The latter, in case of uniform, radial flow, is a cylindrical surface the height of which is the thickness of the sand and the radius, the distance from the well to the area considered in computing the velocity. If this area is located in a sand of 10 meters thickness at a distance of 50 meters from the producing well, the total flow, $Q = 2 \times TT \times 5000 \times 1000 \times 0.065 = 2.04$ million cc. per second or 1.1 million barrels per day. This preposterous rate of production would be necessary to dislodge the gas bubble shown in Fig. 10, consequently, since this rate of production is unattainable, the gas bubble remains locked in place.

If it be assumed that a well is producing at a rate of 10,000 barrels a day, and drop in pressure between two adjacent and unobstructed pores is found to be 5.4 dynes per sq. cm., this pressure is insufficient to cause a displacement of a gas mass.

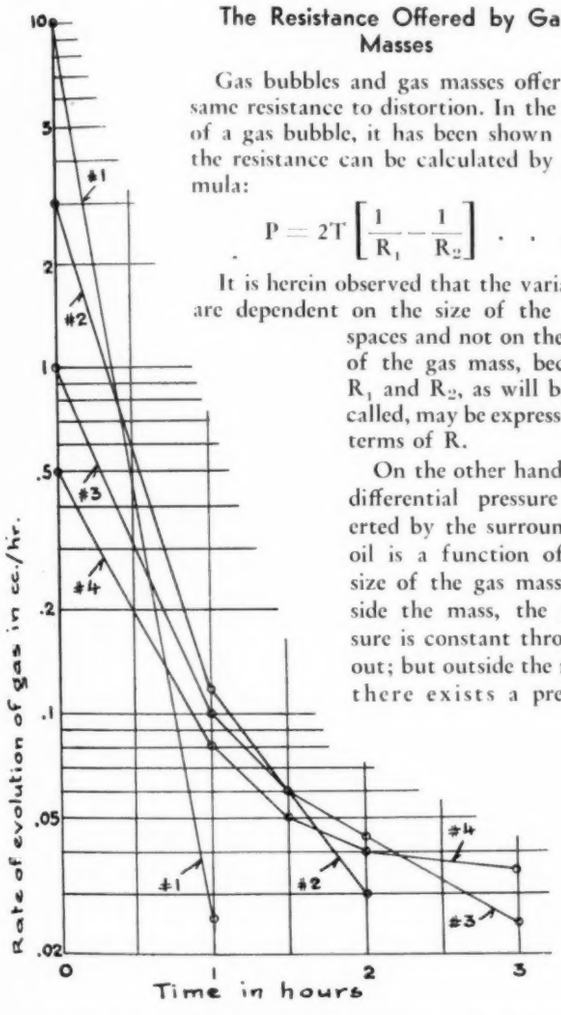


Figure 12: Rate of evolution of gas as a function of oil of interface, the quantity of gas remaining the same

The Resistance Offered by Gas Masses

Gas bubbles and gas masses offer the same resistance to distortion. In the case of a gas bubble, it has been shown that the resistance can be calculated by formula:

$$P = 2T\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad . \quad . \quad .[4]$$

It is herein observed that the variables are dependent on the size of the pore spaces and not on the size of the gas mass, because R_1 and R_2, as will be recalled, may be expressed in terms of R.

On the other hand, the differential pressure exerted by the surrounding oil is a function of the size of the gas mass. Inside the mass, the pressure is constant throughout; but outside the mass, there exists a pressure gradient in the direction of flow that increases with the size of the mass, whereas the resistance to movement offered by the mass remains the same. It is conceivable that as the mass increases, a limit is reached where the differential pressure thus created is sufficiently large to cause the displacement of the gas mass. In the case of the 10,000-barrel well, a drop in pressure of 5.4 dynes per sq. cm. occurs between two adjacent pores, at a distance of 50 meters from the well. The total drop in pressure between two points of the reservoir will be the product of the number of interporous passages through which the oil is flowing and 5.4 dynes per sq. cm., which pressure is sufficiently great to cause the displacement of the mass.

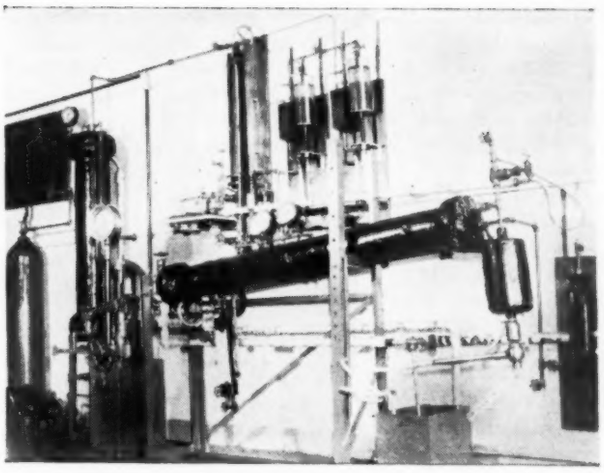


Figure 11: Apparatus for study of behavior of free gas in an oil sand reservoir

Buoyancy may also result in the displacement of a gas mass, because of the differential pressure exerted on the top and the bottom of the mass. Small gas bubbles cannot be moved vertically by the force of buoyancy. A gas mass a quarter of an inch high subjected to a differential pressure of 600 dynes per sq. cm. due to buoyancy will move upward through the sand interstices.

The combined effect of pressure gradient and buoyancy acts simultaneously upon the larger gas masses in bringing about their displacement. In general, gas masses tend to accumulate toward the top of the sand. This tendency is accentuated by the selective growth of gas masses near the top of the sand.

The Rate of Evolution of Gas from Solution

The rate of evolution of gas depends upon two factors, namely: the concentration of gas molecules in solution, and the area of the interface along which free gas may be evolved. This phenomenon is similar to the process of evaportation in which the rate depends on the temperature and the area exposed.

Experiment VII

The experiments below demonstrate the effect of gas concentration and total surface area of the occluded gas masses. The apparatus used consisted of a circular tank (Fig. 11), 60 in. by 3 in., filled with clean silica sand 20-24 mesh, packed to a porosity of 32.6. The oil in the reservoir was saturated with air at atmospheric pressure. Most of the free air in the reservoir had been eliminated with the exception of a volume of 98 cc. at atmospheric or .75 at 2000 lb. pressure. Dead oil was forced into the tank until the pressure was raised to 2000 lb., where it was maintained for varying periods of time. The increase in pressure created an increase in concentration of air molecules in the occluded masses resulting in a diffusion of air into the surrounding oil. Over a

short period of time, only a small amount of air dissolved in the oil, and upon releasing the pressure, the occluded masses returned to very nearly their original volume. With the increase in pressure, the oil surrounding the gas masses rapidly absorbed additional air molecules until a saturation was reached corresponding to the prevailing pressure of 2000 lb. per sq. in. Gases diffuse very slowly through liquids, and consequently, the diffusion of the air absorbed by the oil along the interface into the surrounding oil was very slow, although the concentration along the interface was much higher than that of the adjacent oil.

When the pressure was reduced to atmospheric, the rate of evolution of air was high because the concentration of air along the surface of the oil corresponded to that at 2000 lb. pressure and the area of the interface had very nearly its original value. The rate of production following the release in pressure declined very rapidly, because the total volume of gas in solution above atmospheric pressure was small. Curve 1, Fig. 12, which represents the flow curve of the first experiment, is characterized by a high initial rate and a rapid decline.

In the second experiment, the pressure of 2000 lb. per sq. in. was maintained over a longer period of time, thus enabling the air molecules to diffuse farther and in greater quantity into the surrounding oil. Since more gas went into solution, the volume of the remaining free gas and the size of its interface were less. The concentration of adsorbed air molecules in the surrounding oil was that corresponding to a pressure of 2000 lb. per sq. in. When the pressure was reduced to atmospheric, the rate of evolution of air from solution was also high, but less than in the first experiment, because the concentration along the interface was the same but the surface area was less. Curve 2, Fig. 12, is characterized by a slightly lower initial value but also lower rate of decline because of the larger volume of available air in solution above atmospheric pressure.

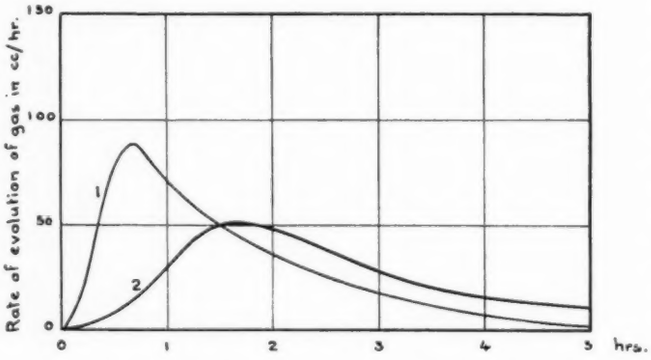


Figure 13: Rate of evolution of gas in an oil reservoir originally devoid of free gas.

The results of the above experiment are tabulated below:

TABLE VI

Free Gas	*Time*	*Gas in*	*Rate of Evolution of Gas at end of*				
cc.	*Hours*	*Solution*	*2 min.*	*1 hr.*	*1½ hr.*	*2 hr.*	*3 hr.*
88.0	½	10*	10.0	0.025	.....	.....	.....
43.4	45	54.6	3.0	0.120	0.060	0.030	.....
33.2	87	64.8	1.0	0.103	0.060	0.043	0.026
26.5	180	71.5	0.5	0.080	0.050	0.041	0.035

DESCRIPTION OF TABLE HEADS

Column 1—Volume of free gas in cc. at atmospheric pressure.

Column 2—Time in hours during which the pressure of the reservoir was maintained at 2000-lb. pressure.

Column 3—Free gas gone into solution during period of time given in Column 2.

Columns 4-8—Rate of evolution of gas from solution in cc. per min., against atmospheric pressure.

Attention is called incidentally to the fact that 88 cc. of air did not entirely dissolve in the given amount of oil (2675 cc.) at 2000 lb. pressure over a period of 180 hours, which indicates the slow rate of diffusion of air into the oil in a sand reservoir in the absence of agitation.

The amount of free air in the above experiments was not negligible and the concentration of air in the oil was limited to a narrow zone surrounding the occluded masses. It is interesting to consider the case in which the concentration with air or gas is uniform throughout the oil and the size and number of the occluded masses are very small. Here, the rate of evolution of air or gas is very small because of the reduced total surface area of the occluded masses. The volume of gas evolved from solution does not materially diminish the concentration in the surrounding oil, and the increasing size of the mass will cause an increasing rate of evolution. This increase will continue until the depletion of gas in the surrounding oil counteracts the growth of the interface, after which a decline in the rate of evolution will take place (Fig. 13). In some cases, the increase in area of the interface and depletion of the oil with gas almost compensate each other, resulting in a constant rate of evolution of gas.

The natural evolution of free gas in an oil reservoir originally devoid of occluded gas follows a general curve similar to that illustrated by Fig. 13. The rate of natural production of oil which depends on the rate of evolution of gas follows the same general curve.

The dissemination of the occluded gas throughout the reservoir also affects the rate of production. Thus, the same volume of gas occurring as small widely disseminated gas bubbles offers a much larger surface than the same volume of gas occurring as large isolated masses. In the former case, the evolution of gas, and therefore the rate of production of oil, is rapid (Curve 1, Fig. 13), the peak of production is high, and the subsequent rate of decline rapid, because of exhaustion of the gas from solution.

In the latter case, (Curve 2, Fig. 13), the rate of evolution is slow because of the reduced total surface. The peak of production is delayed and lower, but the decline is more gentle as more time is required for the gas to come out of solution because of reduced surface and greater distances through which the gas has to diffuse.

Experimentally[2] it is possible to create varying rates of flow from an oil sand by predetermining the degree of dissemination of the occluded gas masses.

In most oil fields, the methods of bringing wells into production cause a rapid evolution of gas in the areas surrounding the well and the curve ascends so rapidly that it is seldom observed. The declining production curve represents only the descending portion of the flow curve. When the production of a well drilled in virgin territory is retarded, the moment a reservoir is tapped for production, the evolution of gas from the oil takes place around selective nuclei, the result of which is a rate of production similar to that shown in Fig. 13. An example of this was the University No. 1 well, at Big Lake, Tex.

* * *

The fourth and concluding article by Ionel I. Gardescu on "The Behavior of Occluded Gas in an Oil Sand Reservoir," will appear in the next issue of *The Petroleum Engineer*. This article will be a continuance of his discussion on an analytical study of the resistance offered by occluded gas.—*Editor.*

*Estimated value. After 12 hours the rate of formation of free gas had decreased to 0.006 cc. per hour and the total volume of gas produced from solution had totalled 5 cc. up to that time.

[2]Gardescu, I. I. Some experiments on the Behavior of Natural Gas in an Oil Sand Reservoir, A.I.M.E. Petroleum Development and Technology, 1932, pp. 467-472.

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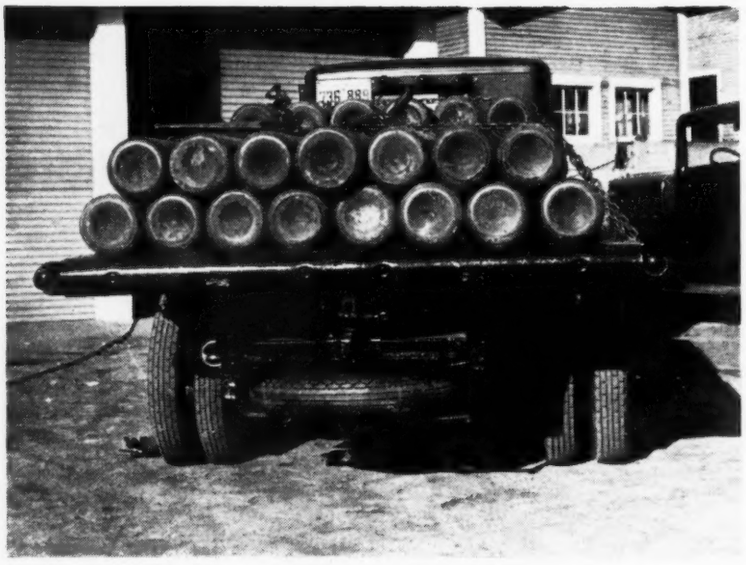

A truck with lights in driving position

TRUCK TAIL LIGHTS PROTECTED BY NOVEL DEVICE

Deep Rock Solves Troublesome Loading Problem

By E. L. BELL☆

THE bothersome and ever-present problem of preventing constant breaking of tail light equipment on oil field trucks and the consequent dangers of operating unlighted trucks on the highways have been successfully overcome in a simple, feasible and effective manner by the Deep Rock Oil Company with a device now being placed on all of the company's trucks. It is a home-made contraption that permits the sliding of the lights into a protected position when they are not in use.

The entire success of this equipment is due to a sliding bracket feature. The majority of light troubles on oil field trucks are due to breakage while loading. Since much of the regular factory lighting equipment is placed in such a position that heavy objects being loaded onto the truck bed are likely to strike them, the breakage of tail lights has been costly in the oil fields.

It is now subject to a heavy penalty in practically all states of the Union to operate vehicles, and especially trucks, without a sufficient lighting system. Therefore, the device has a two-fold purpose. It not only cuts down on the expense of purchasing new lighting equipment or repair of the old, but also reduces the probability of arrest and fine for having no tail lights and it creates a greater factor of safety on the highways.

The device consists primarily of two sliding light brackets, one on each side of the rear portion of the truck bed. All of the trucks are equipped with a 5 3/16-in. iron or steel pipe placed across the rear end of the truck bed. It has for some time been the practice of many oil companies and drilling contractors to equip their trucks with this steel pipe protection so that the beds will not be splintered or broken off while loading heavy oil field machinery. This pipe is utilized as the base onto which are installed the sliding light brackets. Since the pipe is ordinarily installed on oil field trucks anyway, it need not be considered as an item of expense in placing sliding light brackets on the truck. Inside the pipe, two long, narrow strips of metal, usually made from old, discarded rig metal plates, are brazed on to the pipe in a manner that a narrow slot or track is formed. The lights are installed on brackets made from the same kind of metal plates, the brackets are then placed in the slots and are operated up and down the track. When not in use they may be pushed entirely inside of the pipe so there is absolutely no danger of breakage from striking the objects being loaded onto the truck. When it is desired to use the lights, the truck operator need only pull them out with his hand. When in this position the brackets protrude a sufficient distance outward from the truck bed as to be plainly visible. The brackets are bored with a small hole so that a nail or bolt may be placed in the opening to prevent them sliding back into the pipe.

Other lighting facilities on these trucks, besides the regular equipment, include lights across the top of the driver's cab on both the front and rear and small lights placed on the extreme front edges of the truck beds.

The trailers being used by the Deep Rock Oil Company also are equipped with special lighting facilities. These are of the reel type so that sharp turns may be made without breaking the cable. The reel is placed beneath the truck bed and gives slack or gathers slack, as the road condition requires, by unwinding or winding as the truck encounters different road levels or is driven around bends.

☆ Superintendent of motor transport and machine shops, Deep Rock Oil Company.

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East Texas Crude Gives High Gasoline Yield

By A. W. TRUSTY☆

EAST Texas crude, with its high yield of straight-run gasoline, has considerably modified and simplified refining operations. When refining other crudes, especially West Texas crudes, doctor sweetening, and in some cases, acid treating, is necessary to produce a gasoline with a good odor, low sulphur content, and negative corrosion and doctor tests. The gasoline produced by topping East Texas crude, without any treatment whatever, has a very low sulphur content, a good odor, and reacts negatively to corrosion and doctor tests. In cases where the corrosion test is slightly off, this can be corrected by spraying a caustic soda solution in the lines to the rundown tanks.

For summer consumption, very little, if any, natural gasoline is required to blend with the straight-run gasoline to make a satisfactory motor fuel. For winter consumption, compared with the majority of straight-run gasolines from other crude oils, considerably less natural gasoline is required to blend for a commercial motor fuel.

The estimated total ultimate recovery of crude from East Texas is conservatively placed at 1,250,000,000 barrels. With such a large supply of crude available for present and future consumption, the refining characteristics and chemical composition of the products will be reflected in the refineries and sales outlets of a considerable area.

There is very little variation in the physical characteristics or yield of products in samples of the crude taken from various parts of the field.

Tests on crude oil:[1]

	Depth Feet	°API	Sulfur %	Vis. at 100°F.	Vis. at 50°P.	Pour Point	Flash & Fire	Percent Gaso.
Joiner Field	3,592	38.6	.28	40	100	25	Below	35.8
Kilgore Field	3,652	40.0	.29	40	100	25	Room	36.0
Longview Field	3,587	38.4	.26	41	108	30	Temp.	35.0

	Atmospheric distillation to 11° A. P. I. residue	Vacuum distillation to 16° A. P. I. residue
Average yield of products:	*Percent*	*Percent*
Gasoline (410°F. End Point)	36.0	36.0
Kerosene—41.0 °A. P. I.	8.0	8.0
Gas Oil	46.0	16.0
Residue—11° A. P. I.	9.0	....
Residue—16° A. P. I.	....	23.0
Non-viscous lubricating dist. (50-100 vis.)	....	10.0
Medium lubricating dist. (100-200 vis.)	....	6.0
Loss	1.0	1.0

East Texas crude is classed as intermediate or mixed base, according to the method of classification of crudes by Smith & Lane,[2] which is as follows:

Note the A.P.I. gravity of the fraction distilling between 482 deg. fahr. and 527 deg. fahr. at atmospheric pressure. If this gravity is 40 deg. A.P.I., or lighter, the oil can be considered definitely to have a paraffin base. If this gravity is 33 deg. A.P.I., or heavier, the oil has either a naphthene (asphalt) or hybrid base. If it is between 33 deg. and 40 deg. A.P.I., the oil has an intermediate base.

Analysis of gas from Lathrop No. 1 well:

	% By Volume	Gals./1000 cu. ft.
Carbon dioxide	.4	
Illuminants	.3	
Oxygen	.5	
Hydrogen	2.8	
Carbon monoxide	....	
Methane (and nitrogen)	47.8	
Ethane	13.2	
Propane	22.0	
Iso-butane	2.5	.82
N-butane	7.0	2.21
Iso-pentane	1.5	.55
N-petane	1.6	.58
Hexane and heavier	.7	.28
Totals	100.0	4.44

☆ Chief Chemist, Bossier City, Laboratory, Louisiana Oil Refining Corp.

Characteristics of gasoline produced from East Texas crude:

E. P. of Gasoline	300°F	325°F	350°F	375°F	390°F	400°F	410°F	425°F	437°F
% off crude	20.0	23.5	26.4	28.5	32.0	33.0	35.0	38.0	40.0
°A. P. I. Gr.	69.7	64.2	63.4	61.4	60.6	60.3	60.0	58.8	57.9
I. B. P.	90	92	94	95	96	97	98	99	100
10% at	129	145	148	150	152	154	157	160	162
20	147	165	170	172	174	178	182	184	190
30	163	180	190	194	198	200	203	207	218
40	176	202	209	212	216	220	228	238	245
50	187	214	224	226	228	232	240	258	270
60	198	227	237	246	252	260	270	288	296
70	208	237	254	268	272	280	290	310	328
80	221	260	271	296	302	312	323	332	354
90	241	284	301	332	345	348	353	370	390
95	263	308	334	348	362	368	382	403	418
End Point	290	326	346	372	388	397	410	425	437
Recovery	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.5	97.5
Color	+30	+30	+30	+30	+30	+30	+30	+30	+30
Corrosion	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Sulphur %	.01	.01	.01	.01	.01	.01	.01	.015	.02
Doctor	Swt.	Swt.	Swt.	Swt.	Swt.	Swt.	Swt.	Swt.	Swt.
Octane No.	68.	66.5	65.	64.5	60.	57.	55.	52.	46.

A 415 deg. fahr. end point gasoline was analyzed according to the method of Egloff & Morrell:

Unsaturated hydrocarbons	2%
Aromatic hydrocarbons	3%
Nephthenic hydrocarbons	30%
Paraffinic hydrocarbons	65%

The comparatively good knock rating that East Texas straight-run gasoline possesses is due to the presence of the small amount of aromatic hydrocarbons and to the large amount of naphthenic hydrocarbons.

"Aniline Number" determinations were made on 5 per ent fractions from East Texas crude. Note: The aniline number is a rough indication of the inherent base of an oil; a high aniline number indicates a paraffin base or waxy fraction, while a lower aniline number indicates an aromatic or naphthenic fraction.

	°A. P. I. Fraction	Aniline Number
Cut 1	88.6	136°F
Cut 2	76.1	135
Cut 3	65.5	130
Cut 4	59.7	127
Cut 5	55.9	125
Cut 6	50.2	125
Cut 7	48.5	126
Cut 8	44.4	138
Cut 9	42.4	143
Cut 10	39.3	148
Cut 11	35.6	165
Cut 12	34.7	170
Cut 13	33.3	175
Cut 14	31.7	178
Cut 15	30.4	182
Cut 16	29.2	185
Cut 17	28.6	190

These determinations show that the gasoline and kerosene fractions are composed of paraffin and naphthene hydrocarbons. As the fractions become heavier, the content of wax increases and the percentage of naphthenes decreases.

Painter's naphtha, Stoddard's solvent and kerosene from East Texas crude:

	Painter's Naphtha (V&P.M. naphtha)	Stoddard Solvent	41.5°A.P.I. Kerosene	39°A.P.I. Kerosene
°A. P. I. Gravity	57.4	47.5	41.5	39.0
I. B. P.	214	301	356	376
10% at	223	315	404	433
20	227	325	414	453
30	230	331	420	466
40	233	342	426	474
50	236	348	432	482
60	240	354	437	492
70	246	360	442	502
80	254	365	449	513
90	266	380	456	528
95	281	393	464	541
End Point	302	409	496	552
Recovery	98	98	98	98
Sulphur	.007%	.01%	.04%	.05%
Corrosion	Neg.	Neg.	Pos.	Pos.
Doctor	Sweet	Slt. Sour	Sour	Sour
Saybolt Thermo-Vis.	.....	....	351	528
Flash O. C.	.....	....	115°F	170°F
Color	+30	+30	24	21
Burning Test:				
Chimney	.....	....	Good	Good
Wick	.....	....	Good	Good

...*for* CRACKING STILL TUBES, HOT OIL LINES, *etc.*

The development of so remarkable a series of alloys as the U S S Stainless and Heat Resisting Steels has been speedily turned to account by National Tube Company in its service to oil refining, specifically in the 18-8 (18% chromium—8% nickel) alloy. NATIONAL 18-8 Stainless and Heat Resisting Pipe and Tubes are now available, through a wide range of diameters, wall-thicknesses, and lengths, with plain, upset, or otherwise formed ends.

High resistance to corrosion, maximum strength at high temperatures, unusual resistance to oxidation or scaling, dependable uniformity in structure, strength and quality; accurate, controlled heat treatment and exceptional ductility are among the virtues of these widely adaptable chromium-nickel alloy seamless tubes. Economy and durability to a degree never before experienced follow adoption of NATIONAL 18-8 Stainless and Heat Resisting Pipe and Tubes for cracking stills, heat exchangers, ducts, containers, tanks, agitators, and other refinery equipment.

NATIONAL engineers and metallurgists will gladly aid in determining the most effective application of this alloy for any particular service requirement. Ask for booklet, "NATIONAL U S S Stainless and Heat Resisting Pipe and Tubes".

NATIONAL TUBE COMPANY, Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

U S S Chromium-Nickel Alloy Steels are produced under the licenses of the Chemical Foundation, Inc., New York; and Fried. Krupp A. G. of Germany.

NATIONAL USS
STAINLESS AND HEAT RESISTING PIPE AND TUBES

Characteristics of gas oil fraction made by atmospheric distillation of East Texas crude to 10 deg. A.P.I. gravity fuel oil:

Gravity	30.0
I. B. P.	485°F
10% at	535
20	552
30	570
40	592
50	618
60	648
70	688
Flash C. O. C.	260°F
Fire C. O. C.	295°F
Viscosity S. U. at 100°F	41
Pour Test	75°F
Sulphur	.35%
Aniline No.	176°F

Characteristics of fuel oil made by atmospheric distillation of East Texas crude:

% off crude	54	48	28	10
°A. P. I. Gravity	27.6	25.1	21	12.4
Flash C. O. C.	245	260	360	370
Fire C. O. C.	315	335	480	510
Pour Test	75	85	85	90
Viscosity Furol at 122°F.	23	29	85	456
Sulphur	.52	.58	.62	.8
B. S. & W. %	.2	.2	.4	1.0

Results of Cracking East Texas Residuum

East Texas residuum produced by topping the natural gasoline and kerosene was cracked by the flash residuum method on a tank and tube unit under 350-lb. pressure and 900 deg. fahr. transfer temperature.

Tests on the feed stock and tar:

	East Texas Residuum (Fresh Feed)	Feed to Coils	Gas Oil	Distillate
Gravity	26.8	26.5	32.2	55.5
I. B. P.	425°F	380°F	406°F	108°F
10% at	530	466	430	172
20	581	500	440	210
30	630	525	450	237
40	660	548	460	263
50	...	572	472	280
60	...	600	484	305
70	...	636	502	322
80	...	...	524	358
90	...	...	568	388
End Point	...	..	628	425
Pour Test	70°F	50°F	0°F	
Sulphur	.60%	.48%	.30%	.11%

Tests on fuel oil:

Gravity —°A. P. I.	12.0
Flash O. C.	250°F
Fire O. C.	315
Pour Test	40°F
B. S. & W.	1.0%
Vis. Furol at 122°F.	70

The distillate was treated with four pounds of sulphuric acid and rerun to a 400 deg. fahr. end point naphtha.

A. P. I. Gravity	56.6
I. B. P.	109°F
10% at	170
20	209
30	236
40	256
50	272
60	300
70	326
80	348
90	373
End Point	400
Recovery	97
Color	+25
Doctor	Sour
Corrosion	Neg.
Sulphur	.02%
Dissolved Gum	2 mg.
Potential Gum	18 mg.
Octane No.	65

Summary

East Texas crude has a paraffin-asphalt or intermediate base, and yields a high percentage of doctor sweet, non-corrosive, low sulphur gasoline with an exceptionally good boiling range and a comparatively good octane number.

The kerosene yield is low, but the raw kerosene is easily treated and produces an oil of good burning qualities.

The gas oil has the disadvantage of a high cold test which limits its sale for furnace and diesel oil; however, as cracking stock, the yield of gasoline is high and the coking tendencies are low.

The residuum from East Texas crude cracks easily, produces a high yield of distillate which may be treated with a small amount of acid and rerun to produce a low sulphur, low gum and good color gasoline with a fairly high octane number.

REFERENCES

[1] U. S. Bureau of Mines RI 3130.

[2] U. S. Government Bulletin No. 207

Gravity Losses When Handling Hot Crude Oil

By WILLIAM WOELFLIN
Research Engineer, Petroleum Rectifying Company of California

IN the dehydration of crude oil emulsions, the wet crude oil is usually heated to facilitate the separation of the oil and water. When the dehydration is carried out by electrical means the entire dehydration and separation of the oil and water takes place in a tank capable of withstanding a pressure of 30 lbs. per sq. in. There can be no evaporation of either oil or water in this closed tank.

When the water is drawn from the electric dehydrator it usually goes to a sump and then to some waste water disposal system so that evaporation of water is of no consequence.

When the oil passes out the top of the dehydrator it goes to a stock tank and any evaporation of the crude oil fractions causes a loss in gravity and volume of the crude. This means a real monetary loss, since the crude oil is sold on a gravity basis, and the actual volume sold is less if any evaporation has occurred.

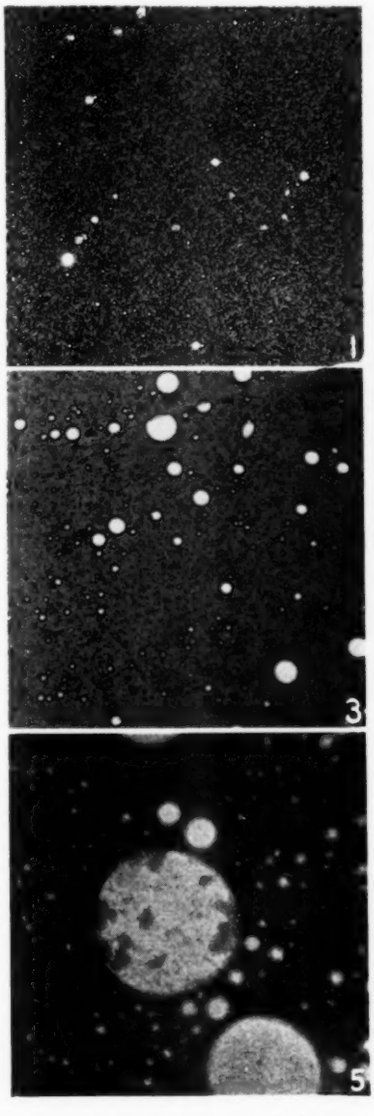
The extent of this loss will depend on the temperature of the oil and the manner in which it is handled after leaving the dehydrator. The oil may pass through a heat exchanger, or cooling tower, and then go into the bottom of a vapor-tight tank, or it may enter the tank through an ell at the top of an open manhole. In the first case there should be practically no loss of gravity or volume, while in the latter case the maximum loss will occur. In order to determine the magnitude of the losses when handling oils at different temperatures, a series of checks were made in the field comparing the actual shipping gravities with the gravity that it is possible to obtain from the crude oil.

These data on gravities were obtained by determining the gravity of the wet oil to the dehydrator by the centrifuge-chemical method and obtaining an average of the cuts and gravities from the run tickets of the last several tanks shipped. In most cases a sample of dry oil was obtained from the top of the dehydrator, by using a sampler to avoid the loss of any light fractions, in order to check the centrifuge-chemical gravity of the wet oil. Most of the samples were obtained from plants that were handling oil from only one well, in order to avoid differences of gravity from different wells.

When the samples of oil for the gravity checks were obtained, complete data were taken, including the exact manner in which the oil was handled between the dehydrator and the shipping tanks. All samples and data were obtained by H. W. Lockhart, who also made the centrifuge-chemical gravity determinations.

All gravities have been reduced to 0 per cent cut for comparative purposes. The loss in gravity is the difference between the centrifuge-chemical gravity of the wet oil and the average shipping gravity, except in cases where the centrifuge-chemical gravity is on a flow line sample. In the latter case the loss is the difference between the treater gravity and the average shipping gravity.

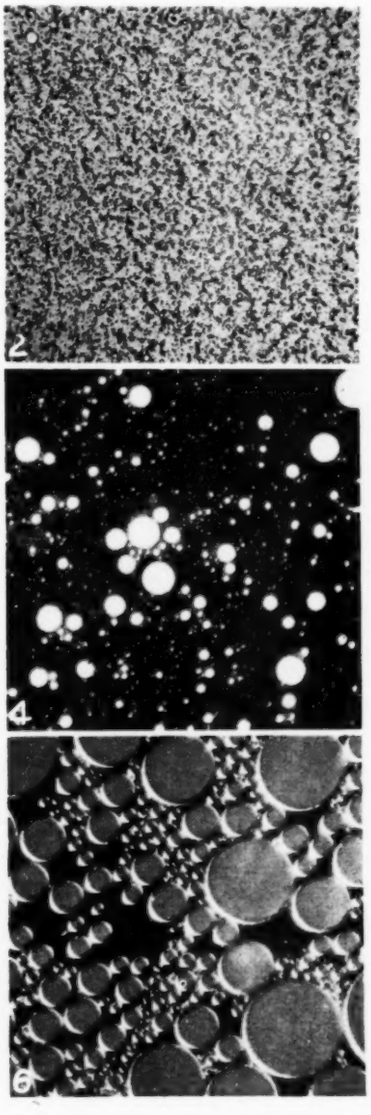
The accompanying data are the result of this investigation. (See table page 38.)



Top—Gravity 14.5°. Cut: Sediment 0.3; water 5.8; emulsion 8.2; total 14.3%.

Center—Gravity 18.6°. Cut: Water 28.0; emulsion 3.0; total 31.0%.

Bottom—Gravity 19.6°. Cut: Water 16.0; emulsion 34.0; total 50%.



Top—Gravity 34.5°. Cut: Water 0.2; emulsion 13.4; total 13.6%.

Center—Gravity 21.2°. Cut: Emulsion 51.0; total 51.0%.

Bottom—Gravity 24.7°. Cut: Water 24.0; emulsion 40.0; total 64.0%.

Sample No.	Field	Temp. of Oil to Tank °F.	Method of Oil Entering Tank	Gravity at 60°F.			Loss in Gravity °API
				Cent-Chem. Gravity of Wet Oil	Dehy. Oil Grav.	Shipping Gravity	
1	Signal Hill	150°	Oil enters thru ell at open manhole at top of tank	24.5	24.4	22.3	2.2
2	Signal Hill	140°	Oil enters thru ell at open manhole at top of tank	28.9		28.0	0.9
3	Signal Hill		Oil enters thru ell at open manhole at top of tank	29.5		28.6	0.9
4	Signal Hill	125°	Oil enters thru ell at open manhole at top of tank	30.2	29.7	28.8	0.9
5	Signal Hill	120°	Oil enters at bottom of tank open manhole at top	30.1	29.9	29.7	0.4
6	Hunt. Beach	140°	Oil enters at top of vapor tight tank	24.1	24.1	23.9	0.2
7	Torrance	150°	Oil enters top near open manhole	17.5		17.5	0.0
8	Torrance	165°	Oil enters top near open manhole	18.9	19.1	18.7	0.2
9	Signal Hill	145°	Oil to bottom at center of tank thru overshot. Open 6" gage hole at top	22.9	23.0	22.8	0.1
10	Signal Hill	148°	Oil enters at bottom of vapor tight tanks	25.2	25.1	25.1	0.1
11	Signal Hill	120°	Oil enters at bottom of vapor tight tanks	25.2	25.1	25.1	0.1
12	Venice	80°	Oil enters at top of vapor tight tanks	22.7	21.9	21.6	0.3

The sample No. 12 from Venice shows a loss of 0.8 deg. fahr. A.P.I. between the flow line sample and the sample from the top of the dehydrator. This oil is produced at 140 deg. fahr. and the 0.8 deg. A.P.I. apparently represents a loss between the well and the wet oil tank.

Sample No. 4 taken from the flow line of a Signal Hill well had a centrifuge chemical gravity of 0.5 deg. A.P.I. higher than the dehydrator gravity, which is also believed to be a loss between the well and the wet oil tank.

The above two tests therefore indicate a loss of gravity between the flow line and the dehydrator. Flow line samples should not be used for determining dehydrated oil gravities owing to the losses that may occur between the flow line and the wet tanks.

On Signal Hill oil there was a loss of gravity 0.9 deg. A.P.I. to 2.2 deg. A.P.I., where the 25 deg. to 30 deg. A.P.I. oil from the dehydrator enters the dry oil tank through an ell at an open manhole on top of the tank. (Tests 1, 2, 3 and 4.) In one of these cases (Test 4), there was a cooling tower which cooled the oil to 125 deg. fahr. before entering the tank. The loss of 2.2 deg. A.P.I. from sample No. 1, which is a 24.5 deg. A.P.I. oil seems to be quite high. However, it must be noted that the oil entering the tank is at a higher temperature, and the wind conditions and temperature could easily account for this high loss.

Two tests were made where the hot oil entered at the bottom of the tank. (Tests 5 and 9.) While the temperature of the oil entering the tank and the gravity of the oil varied widely, (30 deg. and 23 deg. A.P.I.) the losses were small, 0.4 deg. and 0.1 deg. A.P.I., respectively.

Comparing the results on tests Nos. 4 and 5, both tests being on a 30 deg. A.P.I. oil and both oils being cooled to approximately the same temperature before entering the stock tanks, shows that 0.5 deg. A.P.I. can be saved by running the oil in at the bottom of the tank.

Tests 6, 10 and 11, made on approximately the same gravity oil, from Signal Hill and Huntington Beach, show from 0.1 deg. to 0.2 deg. A.P.I. loss when cooled to 140 deg. fahr., and handled in vapor-tight tanks.

The two samples, Nos. 7 and 8, from Torrance, which are approximately 18 deg. A.P.I., show very little loss when run to tanks having open manholes at a temperature of 150 deg. and 165 deg. fahr.

Conclusions

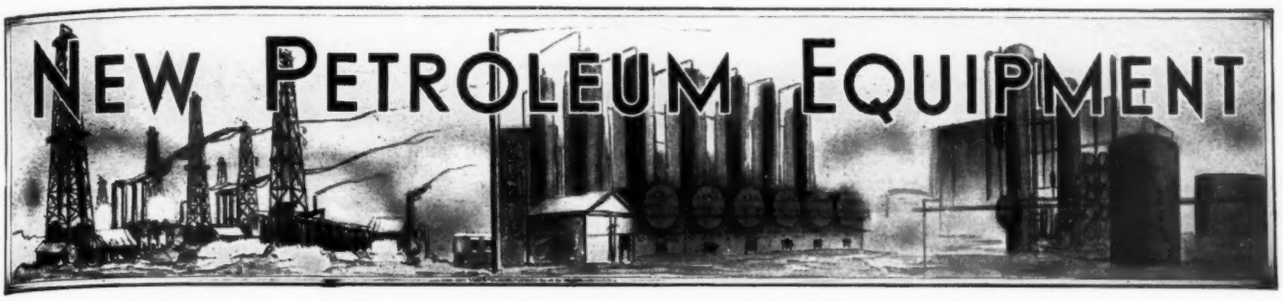
In conclusion we may say that when Signal Hill oil, at temperatures above atmospheric, enters the stock tank through an open ell at the manhole in the top of the tank there is a gravity loss of 1.0 deg. to 2.0 deg. A.P.I., depending on the gravity, temperature and initial point of the oil. For the same oil entering the bottom of the tank the gravity loss will probably not be over 0.5 deg. A.P.I. provided the oil temperature is not over 130 deg. fahr.

There is very little gravity loss in Torrance 19 deg. A.P.I. oil, even though the oil enters the tank at an open manhole at 165 deg. fahr.

From the results of these tests it is suggested that oil from the dehydrators should always enter the stock tanks at the bottom, especially when oils lighter than 20 deg A.P.I. are handled. Heat exchangers or cooling towers will help to minimize gravity losses, and should be used on oils lighter than 25 deg. A.P.I. in order to cool the oil to 140 deg. fahr. or below, depending on the gravity of the oil. When oil enters the bottom of the tank at a temperature of 140 deg. fahr. or below (depending on gravity of the oil) the gravity loss should not be over 0.5 deg. A.P.I. With vapor-tight tanks, added to the above conditions, the gravity loss can be reduced to 0.1-0.3 deg. A.P.I.

No attempt has been made in the above discussion to enter into the gravity or volume loss of oil standing in lease storage, as there have been several excellent articles written on this subject. The above data was taken on oil that is shipped off the lease, only a very short time after dehydration.

Neither has any effort been made to discuss volume losses that occur in handling hot crude oil. The results of the investigation have demonstrated there are volume losses as well as gravity losses when hot crude oils are handled. The losses in volume that occur under similar conditions as those described in the above article will be discussed in a second story of this series on handling hot crude oil, which will appear in an early issue of *The Petroleum Engineer*.



Nickel-Clad Steel Now Available in New Finish and Wider Range of Sizes

NICKEL-CLAD steel is a hot-rolled bi-metal made up of a light layer of pure, solid Nickel bonded to a heavy layer of flange quality steel. The Nickel layer, which can be of variable thickness, as desired, up to 20 per cent of the total plate thickness, provides corrosion resistance and other advantages. This duplex steel is a joint development of The International Nickel Company and Lukens Steel Company, and is produced in the latter company's mills at Coatesville, Pennsylvania.

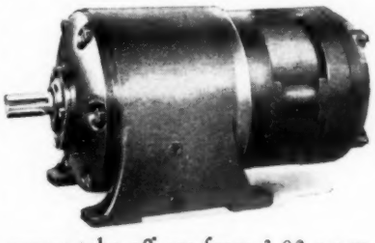
Up to the present time, Nickel-clad steel has been available only in the regular hot-rolled finish, the nickel surface of which carries the tightly adherent nickel oxide film, dark olive brown in color. This nickel oxide finish is formed during the rolling of the bi-metal at high temperatures, and is somewhat similar to the finish on standard hot-rolled steel plates. The manufacturers state that while this type of finish will continue to be produced, a new and finer finish is now available.

With the new finish, classified as "hot-rolled and cleaned," Nickel-clad steel is free from the brown nickel oxide on the nickel side. The cleaning process gives the nickel a matt appearance nearly white in color, with a superior surface. This "hot-rolled and cleaned" finish, however, should not be confused with the bright, lustrous surface of cold-rolled and full finished solid nickel sheet, where refinement is obtained by cold rolling.

Nickel-clad steel is also now available in rectangular plates and circles in a wide range of sizes.

Motor Reduction Unit

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., announces the development of a Motor Reduction Unit for use where low-speed drives are required. A standard round frame type motor is mounted directly on the gear reducer housing, thus forming a compact unit. Helical gears are used, which permit the highest possible efficiency and the most quiet operation.



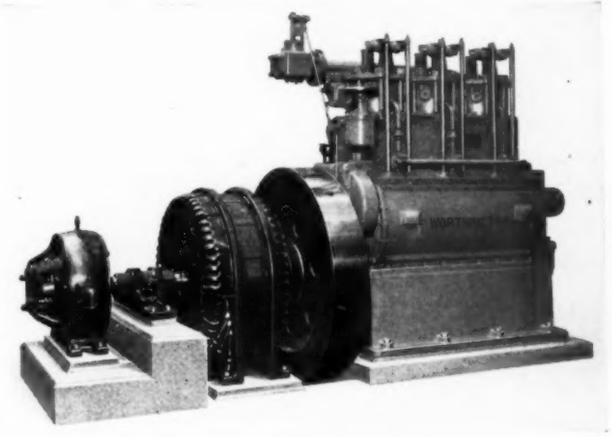
Standard speeds at the power take-off are from 3.02 r.p.m. to 380 r.p.m., but lower speeds can be provided. 6.08 r.p.m. is obtained with the use of a 1750 r.p.m. motor.

The bearings supporting the gear drives are ball or roller type. Lubrication is automatic and continuous, insuring an adequate supply of lubricant at all times. Standard units are arranged for flooring mounting. Units can be supplied for wall, ceiling or vertical mounting. Any desired type of motor may be supplied.

Wider Power Range Vertical Gas Engines

AN IMPROVED line of vertical four-cycle gas engines, covering an unusually wide power range in a variety of cylinder combinations, recently has been announced by the Worthington Pump and Machinery Corporation, Harrison, N. J. These units, the outgrowth of 32 years of experience in the construction of internal combustion engines, are built with one to eight cylinders and 30 to 150 hp. per cylinder, thus meeting all power requirements from 30 to 1800 hp. They may be converted to Diesel operation at moderate expense.

Many unusual details of construction are incorporated in these engines, among them being: A mixing valve, common to all cylinders and adjustable through a single knurled handscrew, is employed on all but the largest units. Separate air and gas mixing valves—independently adjustable for each cylinder—are installed in each cylinder head of the largest engines. In all but the smallest units, air inlet and exhaust valves are carried in removable and interchangeable cages, the exhaust valve cages being water-cooled; in the smaller engines,



these valves (also interchangeable and adjustable) seat directly in the cylinder head and operate in removable bushings.

An attached reciprocating pump circulates lubricating oil through a cast-in duct in the base with cast-in branches leading to the bottom of each main bearing. Two-point force feed lubrication of the cylinders is employed on all but the smallest units.

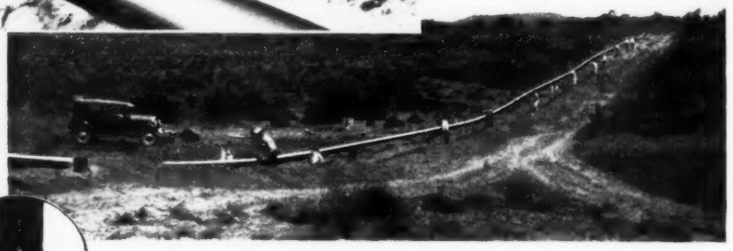
Readily removable at right angles to the engine, the camshaft is driven from the flywheel end by spur gears with silent spiral teeth. A tight cover incloses the entire camshaft assembly, including its lubrication. All essential points, (including the exhaust manifold) are cooled, the principal feature being that the flow of water in all jackets is so directed that high velocities result and there are no dead pockets. Both cylinder liners and heads are readily cleaned through large handholes, and unobstructed access to main and crank bearings is gained through large doors in the front and rear.

SANTA MARIA GAS COMPANY

SELECTS *REPUBLIC ELECTRIC WELD PIPE*

At left—*Swinging Santa Maria Gas line into position over trench.*

Below—*Typical of the hilly country through which the Santa Maria Gas line passes—demanding a high degree of flexibility in the pipe.*



The Santa Maria Gas Company recently completed a twenty-mile extension through rugged country to bring the benefits of gas to consumers in and around Santa Maria, California. The pipe for the line was Republic Electric Weld, 8⅝" diameter, selected because of its many advantages.

Republic Electric Weld Pipe is made by a process of resistance welding. The result is a weld as strong as the pipe wall. No metal is added at the weld, which remains smooth inside and outside and almost defies detection. The pipe is round inside and outside and the wall is of uniform thickness, with all scale and oxide removed. It is suitable for every type of joint.

Large oil and gas companies have used Republic Electric Weld Pipe—thousands of miles of it—in oil lines, gasoline lines and gas lines. Countless strings of Republic Electric Weld Casing and Tubing are now rendering unusual service to producers. Today this pipe comes to you as a proved product—its installation involves no pioneering effort. In fact, engineers conversant with the qualities of this trouble-free pipe use it as a basis for comparison.

A copy of Catalog 210-B will bring you all the facts. Write today.

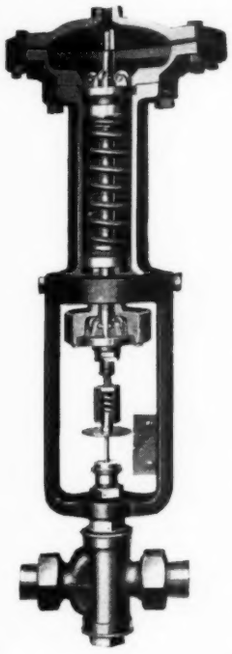
REPUBLIC STEEL CORPORATION

GENERAL OFFICES YOUNGSTOWN, OHIO

REPUBLIC *ELECTRIC WELD*

LINE PIPE • CASING • TUBING

Friction-Free Diaphragm Valve



AFTER more than a year's service on many installations, the Tag Friction-Free Diaphragm Valve is formally announced by the C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y.

This improved super-structure is mounted on Tag V-port Balanced Valves, giving gradual opening characteristics.

Friction is cut down to a minimum by reducing the diameter of the spindle passing through the stuffing box. The spindle is perfectly guided by its upper (large diameter) portion which passes through two roller bearing assemblies, each consisting of four stainless steel rollers.

The spring (single or multiple) is enclosed as is also the diaphragm; a positive indicator is furnished; adjustments are easily made; available with 7½-in., 9½-in. and 11½-in. diameter diaphragm.

Standardized Line of High-Grade Valve Balls and Seats

THE OIL WELL SUPPLY COMPANY, Dallas, Tex., recently introduced a complete new line of high grade valve balls and seats for plunger pumps and working barrel pumps. In order to suit individual well conditions, several standardized types are manufactured. Materials for each type have been carefully selected by extensive metallurgical research and laboratory and field tests so that only the most suitable materials are used for the particular class of service for which each type is intended.

The new "Oilwell" Valve Balls and Seats meet all A.P.I. specifications and are made in accordance with the highest standards of precision workmanship. The cylindrical surface of each seat, where it fits into the cage and bushing, is ground straight for easy installation and removal. The flat surfaces of the flange are accurately ground for positive seal. The seating surfaces are carefully ground for perfect seating of the true and highly polished ball.

The high standard of quality of the new "Oilwell" Valve Balls and Seats is maintained by constant and rigid inspection of workmanship and careful laboratory analysis of all material used. The seating of each ball and seat is carefully tested with a special vacuum-test apparatus.

Each ball and seat is cleaned, dipped in anti-rust oil, wrapped in waxed paper and packed in a tin container for protection against damage and deterioration. Each container has a label of distinctive color, indicating the type of the ball and seat.

The following are the five types of new "Oilwell" Valve Balls and Seats most commonly furnished:

Type B—Yellow label: Hardened aluminum bronze ball and special bronze seat; resists loadstone and corrosion. Material is harder than brass and much more resistant to corrosion and abrasion.

Type C—Blue label: Hardened stainless steel ball and seat; resists corrosion and abrasion. Will not rust, pit or break.

Type T—Red label: Hardened tool steel ball and seat; resists abrasion. Very hard material. Recommended except where loadstone or corrosive conditions exist.

Type BT—Green label: Hardened tool steel seat and hardened aluminum bronze ball; resists lodestone and abrasion.

Type BC—Green label: Hardened aluminum bronze ball and hardened stainless steel seat; resists loadstone, corrosion and abrasion.

For operators who prefer drops and seats, the Oil Well Supply Company now manufactures a high grade product made to the same high standards of precision workmanship as the new "Oilwell" Balls and Seats. Type *C* Drops and Seats, made of hardened stainless steel and particularly resistant to corrosion and abrasion, are regularly furnished.

Chemical Treatment for Oil Wells

THE treatment of oil wells to increase production and rock porosity, covered by patents issued to The Dow Chemical Company, has resulted in remarkable increases of oil in many oil fields. The future work will be carried on by Dowell, Inc., a firm formed and owned by The Dow Chemical Company, Midland, Mich.

Officers and directors of the new firm are: Willard H. Dow, president; L. I. Doan, vice-president; S. W. Putnam, secretary; Russell L. Curtis, treasurer. In addition to those named, A. P. Beutel and J. J. Grebe are directors.

The company is organized to manufacture, sell, purchase and deal in acids and equipment for the treatment of wells, acquire, lease or own oil lands, introduce acids, solvents, etc., into wells. It is primarily for using the Dow Method for increasing the flow of oil and gas wells.

District representatives are now located in all oil states producing in suitable formations with the exception of Montana and Wyoming. Equipment is being put into these fields as rapidly as possible to take care of the demand for this service. This service should not be confused with the so-called acid treatments which were used without success in many different fields. Dowell Service not only consists of suitable solvents for the pay strata, but includes protective measures, directional facilities for handling the acid attack, brine control methods and many other factors to insure best results without injuring the well.

Lever-Operated Master Stations

FOR use under severe weather or atmospheric conditions, a new line of master stations has been announced by Cutler-Hammer, Inc., 415 North Twelfth Street, Milwaukee, Wis., manufacturers of electric control apparatus. Radically different from the usual master stations, these are operated from levers placed on the side of the case, instead of from push buttons on the front.

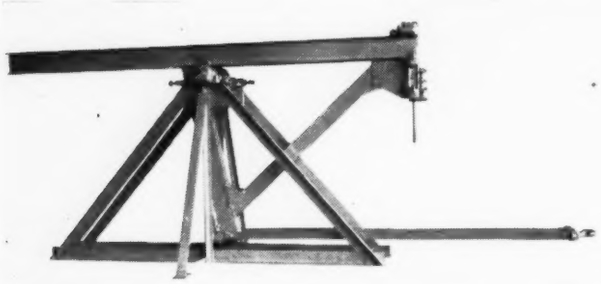
It is claimed that by this unusual construction, an absolutely watertight case is secured. The shafts of the levers operate through stuffing boxes, and the cover joint is sealed by a rubber gasket.

The stations use standard, heavy-duty push button elements, mounted on removable individual moulded bases, fully enclosed. The stations are supplied in all normal ratings in one button (on and off)—two button (start and stop)—or three button (hoist, lower, stop).

National's Types D-100 and D-130 Pumping Jacks

THE National Supply Companies have added to their line of Pumping Jacks a new design known as Types D-100 and D-130. These jacks are designed for the long stroke pumping of deep wells and are recommended for use with the National 12-C or 15-C Band Wheel Powers or the New National G-100 Geared Power.

The Type D-100 Jack has a rated polished rod load of 10,000 pounds and a rated stroke of 42 inches. For larger and heavier Type D-130 the rated load is 13,000 pounds, with a rated stroke of 48 inches. These capacities, both for load and stroke, are very conservative, providing a greater margin of safety than usual. The entire jack is fabricated from structural steel by electric arc welding.

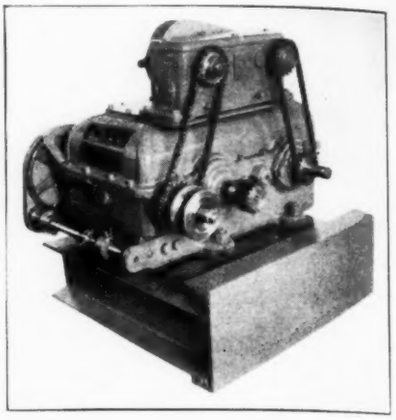


One of the important features of these Type D Jacks is the straight lift, developed by a linkage which in lifting the polished rod approximates a vertical line within a fraction of an inch. This small variation occurs at the top of the stroke where the angular movement of the rod is almost imperceptible. Further, the design is such that any eventual wear will not affect the accuracy of the motion. There is no bending of the polished rod, as the linkage does not touch the rod except at the clamp.

The Type D Jacks are entirely self-contained and self-supporting, requiring only the main foundation block, and eliminating the use of dead men, anchor rods or turnbuckles. Actual field experience has demonstrated that they furnish a most economical installation and provide long, dependable service with highest efficiency.

Automatic Time Cycle-Controlled Variable Speed Transmission

THE LINK BELT COMPANY, 910 South Michigan Avenue, Chicago, Ill., has developed a variable speed transmission unit that involves automatic time cycle control and unusually close speed control.



Of special interest in connection with such a mechanism, are the precise control of speed; the facility with which either a decrease or an increase in speed may be obtained; and the fact that special speed curves are possible. The unit illustrated (the second one built) is a Link-Belt P.I.V. Gear, with special speed reduction unit mounted on top and connected by roller chain drives to the gear's constant speed shaft (at right) and to its control screw (at left), the complete mechanism being mounted on a fabricated steel base for bolting to the frame of the machine to be operated.

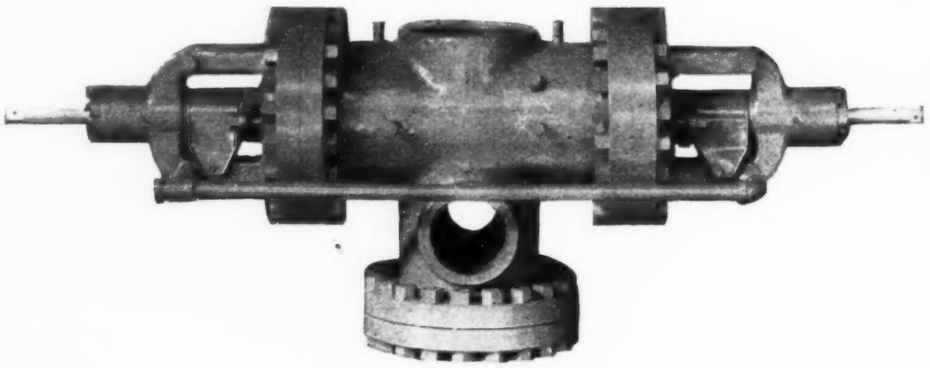
The constant speed shaft of the gear is directly connected through a coupling, and operates at 751 r.p.m. The variable speed or output shaft has a starting speed in the cycle selected, of from 500 to 1100 r.p.m. A silent chain drive connects this shaft to the main shaft of the machine controlled.

When a desired combination and setting have been determined and must be repeated, a special indicator and limit stop are used. From the far end of the control screw a gear drive operates the indicator shaft, on which is a traveling indicator pointing to a scale of the width of the gear box. The locking nut can be set to permit an exact return manually to the starting speed.

"MP" Series Blowout Preventer

CAMERON Iron Works, Inc., Houston, Tex., has recently placed on the market the "MP" Series Blowout Preventer, which combines two proven principles of well control—fluid operated and hand operated, both in one. It is fluid closing and manual opening.

When danger of blowout warns, the driller closes the rams instantly and securely through the fluid operated feature by a mere 90-degree turn of a valve. This forces fluid under pressure to rear of the rams and securely holds them in place around the pipe that is in the hole. After the fluid has placed the rams in the closed position, the rams can be securely locked by the hand screws. When danger of blowout is past, the driller releases the rams manually, at his leisure, from a wheel control at the edge of the derrick floor.



Connections for handling fluid are made from either boiler or slush pump or both, as desired. These connections are made when the preventer is installed, and are always ready.

A single screw at each end of the preventer not only locks the rams in the closed position, but also is used to release the rams and completely open the preventer.

The new design permits converting of a manually operated preventer to this improved type.

NATIONAL GEARED POWER

A dependable power, with double cranks, built to give many years of satisfactory performance.

With this power, high pumping speeds are possible as the lubricating system does not limit the speed.

Heat-treated gears, rigid roller bearing mountings, and ample oil circulation insure enduring service.

Timken Roller Bearing EQUIPPED

TYPE G-100

Bulletin No. 1032-A free on request.

THE NATIONAL SUPPLY COMPANIES

W. G. SKELLY

W. G. Skelly, president of Skelly Oil Company, recently underwent an operation for appendicitis at St. John's Hospital in Tulsa, Okla. Hospital attendants report Mr. Skelly's condition rapidly improving. He is expected soon to resume his duties in directing the activities of his company.

Fred (Pete) Wallace, Mid-Continent representative of Link-Belt Company, Indianapolis, Ind., was a recent visitor in Dallas. He has been spending most of his time in the new Conroe field.

Jim Morgan is now associated with the Webster Engineering Company, Tulsa, Okla. He has established his headquarters at 2065 Montgomery Street, Fort Worth, Tex.

Joe Fuller, oil industry representative for Bartlett Hayward Company, has now completely recovered from his recent operation for appendicitis.

L. H. Jones, field foreman for the Continental Oil Company's production department, is now located at Navarro, Tex. He was located at Mexia for many years.

H. A. Scott and Blake Dirickson, formerly with the Sovereign Oil Corporation of Tulsa, Okla., have resigned and formed a partnership to operate independently in the Mid-Continent field. They have established offices at 408 Philtower Building, Tulsa, Okla.

E. H. GRISWOLD

V. V. Jacomini has been made district manager for C. F. Braun & Co., with offices in the Exchange Bank Building, Tulsa, Okla. Mr. Jacomini has been connected with the Alhambra, Calif., office of the Braun organization for many years.

E. H. Griswold, formerly chief production engineer for Continental Oil Company at Ponca City, Okla., has been transferred to New York City, where he will be technical advisor to D. F. Moran, president of the company.

E. J. Hayden of Chicago, central division manager of The Linde Air Products Company, was elected president of the International Acetylene Association at its annual business meeting held in Philadelphia recently. Mr. Hayden had been vice-president of the association. H. B. Pearson of Compressed Industrial Gases, Chicago, was elected vice-president to succeed Mr. Hayden.

I. D. Craig, district superintendent for The Texas Pipe Line Company, has moved from Olney to Electra, Tex.

T. A. Tisseur, field foreman for the Cosden Oil Company, has been transferred from Odessa to Penwell, Tex.

Robert B. Bowman, formerly research engineer for the Standard Gasoline Company at Huntington Park, Calif., has been transferred to the main offices of the Standard Oil Company of California at San Francisco.

R. T. SHIELS

R. T. Shiels, district manager Industrial Department of General Electric Company, Dallas, has been elected vice-presi- of the Dallas Electric Club.

R. Van A. Mills, vice-president and general manager of the Hudson's Bay Oil and Gas Company at Calgary, Alberta, Canada, has been appointed to the position of chief production engineer in Continental Oil Company's general offices at Ponca City, Okla. Mr. Mills will also retain his position with the Hudson's Bay Oil and Gas Company, a Conoco subsidiary, and direct its activities from Ponca City. Since 1906, when he graduated from the Columbia University with an Engineer of Mines degree, he has accumulated valuable experience in his chosen profession, both in the United States and abroad.

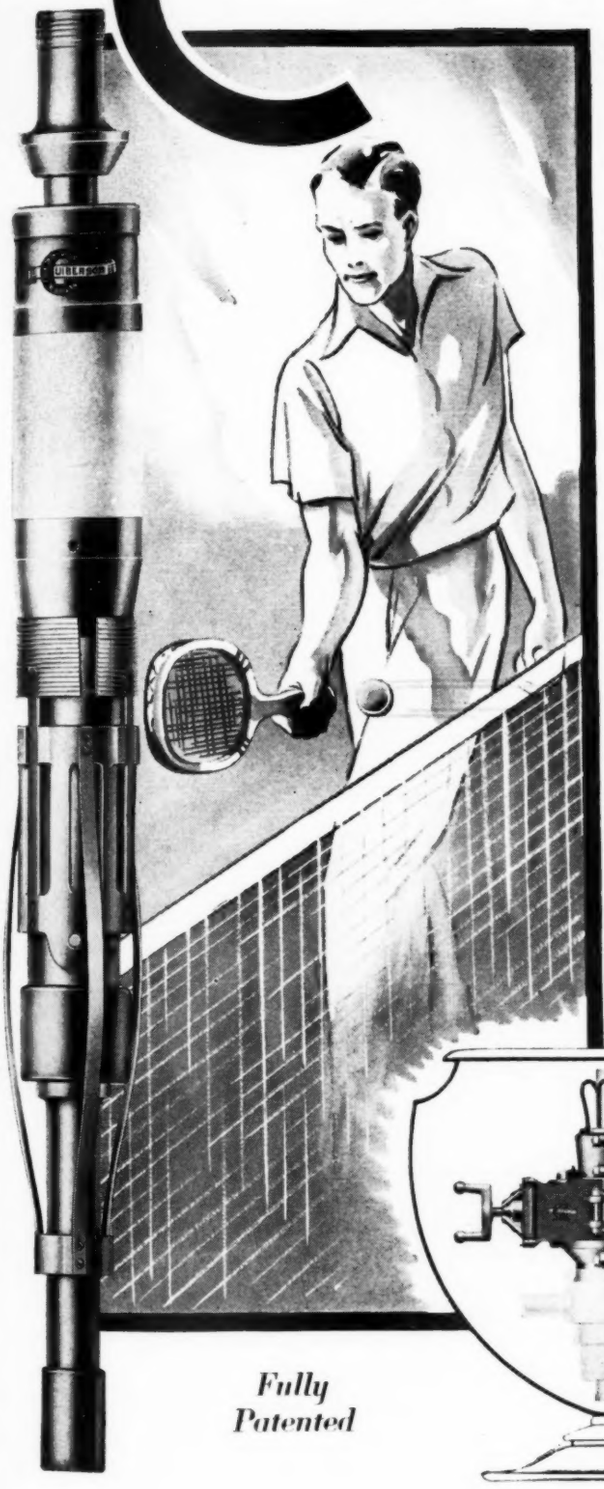
F. W. Willoughby, station engineer for The Texas Pipe Line Company, has been transferred from Louann, Ark., to Port Allen, La.

R. R. Yancy, tool pusher for the Robertson Drilling Company, is now residing at Fort Worth, Tex. He was formerly located at Devine, Tex.

Richard Higgins, Tulsa, Okla., drilling contractor, is reported to be convalescing rapidly from a recent appendicitis operation.

CONTROL

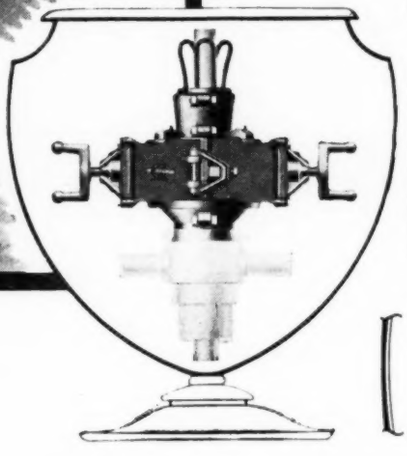
MEANS AS MUCH TO A FLOWING WELL AS IT DOES TO A TENNIS STAR



OBTAIN IT WITH THE GUIBERSON Control Head Packer

Perhaps in no other game does energy flow so rapidly as in tennis. Lack of control means irreparable losses in stamina and results. A well flowing haphazardly through the casing is gushing out its life and energy in like manner.

The Guiberson Control Head Packer confines the flow to the tubing, regulating the amount of gas necessary to lift the oil to the surface, thereby conserving this valuable energy and postponing the day when the well has to go on the pump. The gravity of the oil is also preserved, by maintaining surface pressure in the well. Don't enter your well in the game of profit and loss without insuring the precious control that makes a winner.



Fully Patented

TO PACK FLOWING WELLS

The Guiberson Tubing Oil Saver, set on top of the casing, confines the flow while the packer is being run. Recommended for safety and economy. Rubbers permit passage of tubing collars and Saver can be opened wide to admit Packer or Tubing Catcher.

"Better Be Safe Than Sorry"
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GUIBERSON

BETTER BE SAFE THAN SORRY

Directional Surveys of Vertical Deviations in Wildcat Tests Have Proven Valuable

THE oil industry quickly recognized the benefits and rapidly accepted the principles of straight hole drilling, and now this advanced drilling technique is being further developed as a result of the desire to have exact knowledge of bottom-hole locations, obtained by measuring the orientation of the hole with directional survey instruments. This information has proven important and very valuable for the production, drilling and geological departments. In most instances, work of determining the direction and degree of vertical deviation of drill holes has been more widely applied in fields being extensively exploited, but it is just as valuable for wildcat wells, particularly in regions where the producing structures are frequently small in area.

Briefly, the value of directional surveys in wildcat wells may be summed up as a means of securing accurate knowledge of formation depths and preventing condemnation of producing reservoirs that might be missed because of a fault or long and narrow shape, or because of the apparent structural low of the horizon. Often, wells have been made to appear low on the structure due to the depth at which the sand was encountered, when actually a crooked hole has resulted in the drilling of many extra feet. Even when straight hole drilling is practiced, deep tests sometimes vary sufficiently from vertical to necessitate drilling of many extra feet to reach a much desired horizon. The exact number of additional feet required can easily be determined by a survey of the hole with a number of improved devices now on the market, and from such data correct geological correlations may be made. Many companies, however, are now going further into the matter by making directional surveys of the hole, and by thus determining not only the degree of the deviation from vertical but also the direction that the course of the hole has taken, secure minute data on sub-surface conditions that in many cases have prevented geological condemnation of an area. In regions of small producing areas operators have been able to tell in which direction they have missed the structure, and then are in a position to take advantage of the information in making the location for the next test.

One of the areas in which orientation of drill holes from vertical is being frequently determined in wildcat tests is the Texas Gulf Coast. The producing regions or pools in this territory are closely related to salt domes, it being the site of the greatest collection of salt domes in the Western Hemisphere, and these are the geological structures that form the sub-surface oil reservoirs. As a result the amount of producing acreage within each field is ordinarily small and often of irregular shape. Operators of the sector practice straight hole drilling in a careful and thorough manner, but even then wells of 6000 or more feet sometimes vary to a degree that the bottom of the hole may miss its intended destination because of the narrow limits of the reservoir.

There have been numerous instances in the history of petroleum when wildcat wells have been but one or two locations off the producing structure, and frequently in such cases an underlying oil reservoir has remained untouched for several years. While by far the greatest majority of these examples would be dry holes under any condition because of the surface location, a few of them are perhaps the result of the drilling of holes that wandered from the vertical in a direction away from the producing structure.

Often, the inaccurate geological information obtained in these wells could have been corrected had the course of the hole been determined. An example is to be found in a Gulf Coast test that was expecting the salt at 4000 feet, but encountered the formation at 3400 feet. The first inclination was to believe that the hole had strayed from vertical along a course toward the center of the dome, but a survey of the well with orientation instruments showed the direction assumed by the hole was away from the dome rather than toward it and that a tongue projecting from the dome accounted for the shallowness at which the salt was found.

A condition frequently found in the Gulf Coast prior to straight hole drilling was the wandering of the hole from vertical until its base was so far removed from directly beneath the surface location that the producing reservoir was sometimes missed entirely or made to appear very low on the structure. This resulted in the spending of thousands of dollars on the part of the operators, and frequently a large number of dry holes would be drilled around a known salt dome before the oil producing area would be found. Now, due to straighter holes and directional surveys, the percentage of dry holes has been materially reduced while an additional advantage has been the near elimination of dry holes in proven territory.

It is hardly necessary to discuss from all angles the importance of drilling straight holes, as the subject has been extensively and freely discussed in many articles. The year 1928 saw the commencement of widespread efforts to drill straighter holes, and the advancement of straight hole drilling technique has taught the driller and contractor that a hole starting to go crooked can be corrected, if the deviation is observed in time, which means that measurements must be made at regular periods of time.

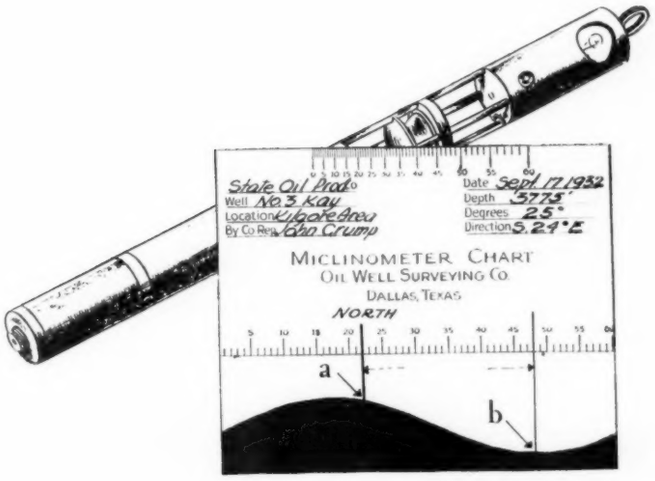
The outstanding troubles produced by crooked holes are the failure of the holes to reach their proper destination, inaccurate geological correlation, operating difficulties during the life of the wells, property line question, possibilities of losing the hole, and the additional footage, with its extra cost, required to reach a producing horizon with an off-vertical hole.

These factors are the background for the now greatly improved technique and equipment used in determining the verticality of drill holes and for the recent acceptance of the idea that the direction of the angle from vertical is another important factor. Many companies are using directional surveys to secure more proper well spacing (see *The Petroleum Engineer*, July, 1932), while other companies are rapidly adopting the practice as a part of wildcat operations.

The MICLINOMETER

Apparatus and Method Patents applied for covering the principal features of the MICLINOMETER

For Straight Holes



The MICLINOMETER (Mike) is an instrument used in drilling oil wells to guard against deviation before it becomes a serious matter.

The MICLINOMETER is operated by a specially designed regulator, thereby assuring positive operation at any predetermined time and any desired depth.

The MICLINOMETER records a permanent record on a special chart. No plumb bob, orifices, discs, magnets, etc., are used.

The MICLINOMETER is run into the well at frequent intervals through the drill pipe, on a measuring or other line. The information obtained enables the driller to maintain a straight hole and the time required is less than with other methods. Any driller can operate the MICLINOMETER, previous experience not necessary.

The MICLINOMETER was developed to meet the need for a scientific, accurate and rapid method of recording the *inclination* of oil wells and is the least expensive method for obtaining this information. Charts sufficient for 500 surveys per year are furnished with the instrument. These factors make well surveying routine practice.

Representatives in Wichita, Kan., Dallas, Tex. Houston, Tex., Tyler, Tex., or Communicate Direct with the

OIL WELL SURVEYING COMPANY

Tower Petroleum Building

DALLAS, TEXAS

The instrument, including the carrying or shipping case, weighs only 68 lbs. Size 8"x9"x35". Length assembled 65" O.D. 2". Weight 32 lbs.

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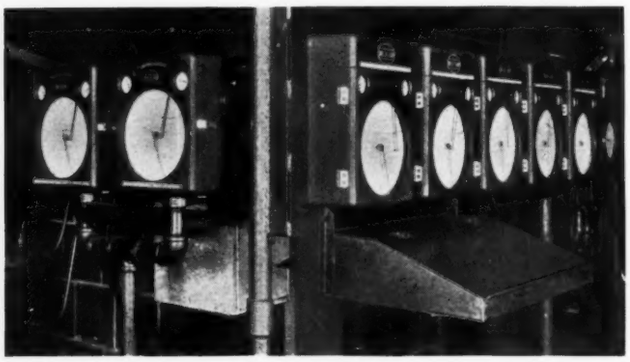
Oil Well Surveying Co., Tower Petroleum Bldg., Dallas, Texas:
Send your lease agreement and instruction sheet for the MICLINOMETER to

Name *Company* *Address* *City*

Is Your Plant Under CONTROL



for the Battle *of* 1933 ?

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If you have been too close to the job to keep track of recent Neilan developments, take a minute now to get the whole story. A letter will bring it.

**A battery of Neilan Compensated Control Instruments now furnishing improved control for the Shell Petroleum Corp. in the recently completed refinery at East Chicago, Ind.*

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NEW YORK, 19 Rector St. . . . . Rudolph B. Werey, Mgr.
PHILADELPHIA, 930 North Front St. . . . Baeuerle & Morris, Inc.
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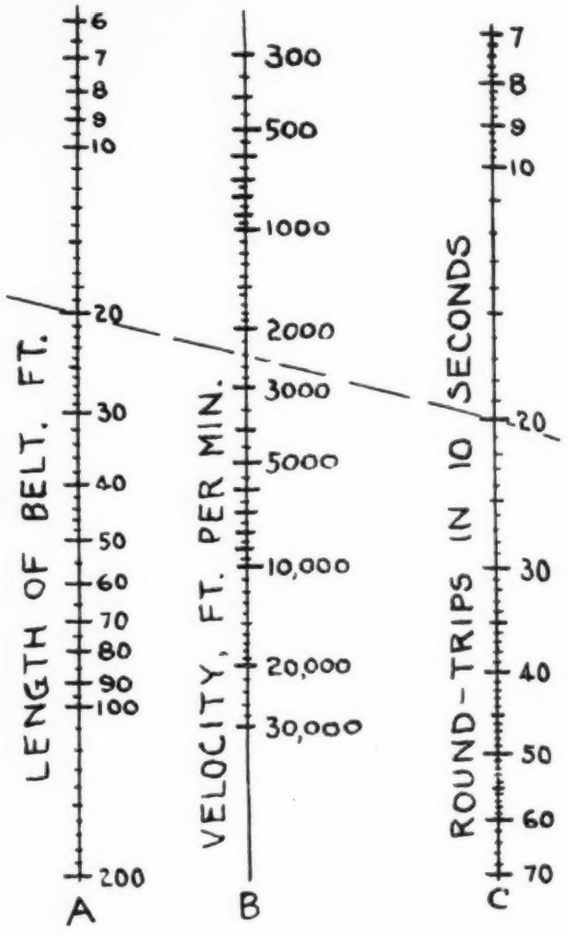
5566

Finding the Velocity of a Belt Without a Speed Indicator

By W. F. SCHAPHORST, M.E.

IT is easy to determine the velocity of most belts without the use of a speed indicator by applying the following simple kink:

Make a chalk mark or any other kind of mark that will be visible on the outside of the belt. This can usually be done while the belt is moving at full speed.



Then estimate the length of the belt in feet. If you want greater accuracy, *measure* the length of the belt, or compute the length in accordance with the many formulas on belt length that are to be found in almost any engineering handbook or belt catalog.

If the belt is 20 feet long, you now know that every time the chalk mark makes a "round trip" the belt travels 20 feet.

Next, take out your watch and count the number of round trips in 10 seconds.

Then apply this chart. In an instant the chart will give you the velocity of the belt in feet per minute.

For example, if the belt is 20 feet long, and if it makes 20 round trips in 10 seconds, connect the 20 in column A with the 20 in column C, and the intersection of the connecting straight line with column B gives the answer as 2400 feet per minute. See the dotted line drawn across this chart.

To count rapidly, where belts are short and speeds high, use the fingers of one hand and count only to ten, counting over

and over. Use the fingers for keeping tab on the number of tens. One can count to ten more quickly than from ten to twenty or from twenty to thirty. Try it and be convinced. Thus to count to thirty with utmost speed, simply count to ten three times in succession. The reason for this is that all of the numbers from one to ten are words of one syllable—all excepting "seven," which can be shortened to "sev" for the sake of speed.

Inversely, this chart can be used for determining the length of a belt. Thus if you have a speed counter, take the r.p.m. of the pulley in the usual way and compute the velocity of the belt in feet per minute. Then count the round trips of the belt in ten seconds. A straight line through the known points in columns B and C will give the belt length in column A. But, of course, don't depend on the result as being absolutely accurate. For absolute accuracy, measure the belt length with a steel tape.

Cooper-Bessemer Celebrate 100th Anniversary

The Cooper-Bessemer Corporation, Mount Vernon, Ohio, is celebrating its 100th anniversary during the year 1933.

B. B. Williams, president of the company, has made the following announcement: "Our company was founded in 1833 by two brothers, Charles and Elias Cooper. The original foundry was a primitive affair according to present standards. The cupola fan was driven by a horsepower rig and much of the hand work of charging, tapping and pouring was done by the proprietors themselves. From this humble beginning our company has made steady progress in spite of adversities, recurring financial panics and the changing demands of industry.

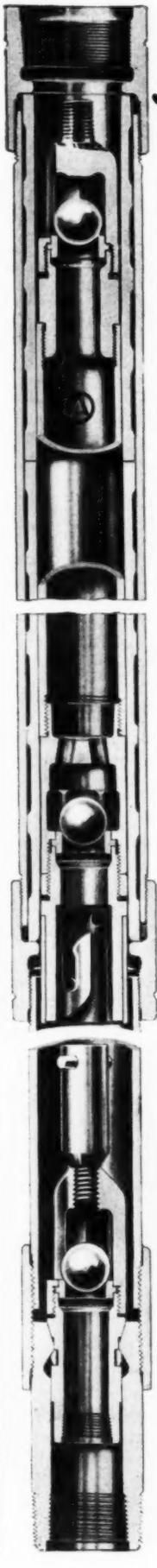
"Building at first the simplest type of steam engines, we have, through the years, manufactured locomotives, blowing engines for blast furnaces, farm tractors, Corliss steam engines and the present internal combustion gas and oil engines. Thus we have always devoted our efforts to the production of power machinery for various purposes.

"By dint of hard work and the patronage of our many friends, we have attained this milestone in our history. The first hundred years are the hardest, we are told, but with your continued coöperation we shall launch out on another century with renewed devotion to our task."

A.P.I. Mid-Year Sessions Set for May

The mid-year meeting of the American Petroleum Institute for 1933 will be held at the Mayo Hotel in Tulsa May 17, 18, and 19, according to announcement made from the general offices of the Institute at New York. Dates for the meeting were chosen at the December meeting of the Executive Committee, and announcement was withheld until further arrangements could be made.

The sessions of the three divisions of the Institute—production, refining, and marketing—at Tulsa will celebrate the third year that mid-year meetings have been held. In 1931 three separate mid-year divisional meetings were held. The production division met in Dallas in June, the marketing division in Chicago in March, and the refining division in St. Louis in April. Last year all three divisions were brought together in Tulsa in June.



Axelson

STILL BUILDS THEM

New pumping problems mean new ideas of production. New ideas in turn mean new pump designs and construction.

In building for every phase of oil well pumping, we have not lost sight of "old reliable"—the Axelson Top Collar Both Ends Liner Pump.

Designs may go, pumps may change, but this pump goes steadily on, keeping old friends and winning new ones.

The T. C. B. E. embodies every desirable feature of liner pumps. Simply constructed, it handles large volumes of fluid, is economical to buy and economical to operate. All Axelson pump fittings are finished to A.P.I. tolerances, making possible varied valve and plunger combinations. Around this T.C.B.E., Axelson first built up their slogan, "Interchangeable Pumps for International Service."

AXELSON T.C.B.E. LINER PUMP WITH RITTER STANDING VALVE

This pump is particularly adaptable for handling large volumes of fluid. The working valve in the lower end of the plunger eliminates the possibility of gaslock, while the Ritter type standing valve may be readily pulled for inspection.

Axelson Manufacturing Company

P. O. Box 710, Vernon Station, Los Angeles

Tulsa New York, 50 Church St. St. Louis

Mid-Continent Representatives

Frick-Reid Supply Corp.
Great Northern Tool & Supply Co.
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Axelson Pump Liners, cast from the finest grey iron, are finished by scientific honing.

PUMPS

FLEXCO

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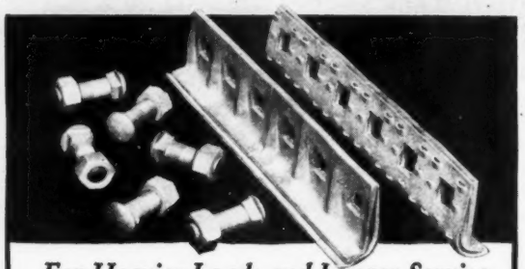
DEEP WELL
Belt Fasteners



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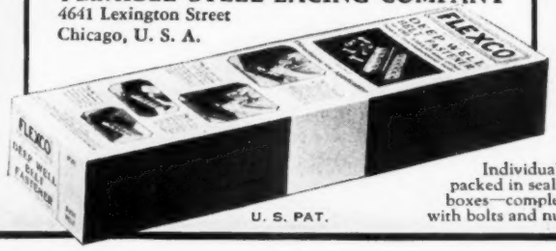

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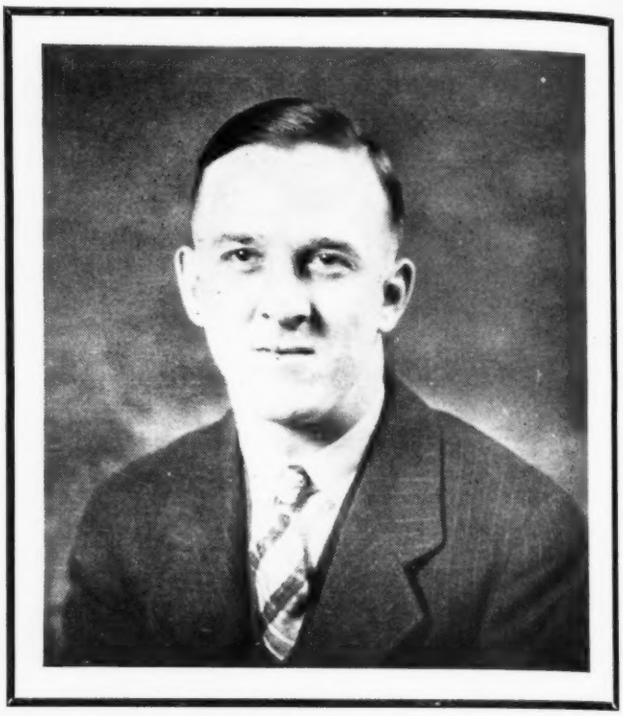
Death of James H. Dameron

JAMES H. DAMERON, who had been Oil and Gas Transportation Editor of *The Petroleum Engineer* since its organization, passed away on December 30 in the City Hospital at Okmulgee, Okla. His death was attributed to an attack of pneumonia, which followed a brief illness from the flu.



Jimmy Dameron was a valued member of the oil industry's writing profession, and enjoyed an exceptionally wide acquaintance because of his engaging personality.

Dameron, the son of Mr. and Mrs. W. T. Dameron, Tulsa, Okla., was born in Huntsville, Mo., on Oct. 5, 1900. The major part of his education was gained in this town, where he remained until the United States entered the World War. He enlisted in the Marines early in 1917, and was stationed in the Virgin Islands.

A few years after the war he joined the staff of the *Tulsa Daily World* as police reporter. During the three years he was associated with the *World* he served a part of his time as assistant to Paul S. Hedrick, oil editor. Upon leaving the *World* in 1925, he became oil editor of the Okmulgee *Democrat*, after which he went to Shreveport, La., where he represented *The Oil and Gas Journal* as correspondent for the Arkansas and North Louisiana fields.

Later, the *Journal* sent him to Fort Worth, Tex., where he headed the bureau covering the Texas Panhandle, West Texas, North and Central Texas and East Texas areas.

With the organization of The Petroleum Engineer Publishing Company, Dameron resigned from his previous position in order that he might accept the duties of oil and gas transportation editor of the new oil magazine. This was in the spring of 1929, at which time he moved his family back to Tulsa. He resided in Tulsa until April, 1932, when headquarters of the company were moved to Dallas.

Dameron was married to Miss Orella Robe, daughter of Mr. and Mrs. John Robe, of Okmulgee, in 1928. Mrs. Dameron has three children: James Holt Dameron, 4 years old; Jane Ann, 2 years old, and Nancy Jean, 1 year old.

Funeral services were conducted at the First Presbyterian Church at Okmulgee. The body was taken to Tulsa, where it was buried in Memorial Park cemetery.

THE WORLD PETROLEUM DIRECTORY, covering the United States and foreign countries, is off the press and is being distributed by Dudley W. Moore, Box 1821, Tulsa, Okla.

Successor on an enlarged scale to the Petroleum Register, this latest work is the largest compilation ever made of oil producing, pipe line, refining, natural gasoline, marketing, royalty companies and individuals engaged in the oil business. There are 550 pages, listing more than 15,000 companies and individuals. Detailed reports on each company gives the names of officers, operating personnel, list of properties, financial setup, branch offices, etc.

WAUKESHA MOTOR COMPANY, Waukesha, Wis., has issued a bulletin answering five vital questions frequently asked by oil industry managers. In addition, details of vital parts used in the Waukesha engines are given.

RECIPROCATING PIPE LINE PUMPS is the subject discussed in a new bulletin printed by Goulds Pumps, Seneca Falls, N. Y. The pumps described in this bulletin incorporate many improvements in design.

SAND, GRAVEL AND ROCK PUMPS as manufactured by Byron Jackson Company, Berkeley, Calif., are described in a newly published booklet, known as Bulletin No. 322. Mechanical descriptions and general uses of these pumps are fully given in the bulletin.

THE CARPENTER STEEL COMPANY, 100 Broadway, New York City, has published its first bulletin on welded stainless steel tubing. The bulletin carries, in addition to general information, data on the advantages of this type tubing, its physical properties and working instructions.

CATERPILLAR THIRTY-FIVE CATALOG has been published by the Caterpillar Tractor Company, Peoria, Ill. This catalog is a forty-page, well illustrated one, that gives all the mechanical specifications of this new tractor. It should prove of interest to oil industry users of tractors.

A NEW STEEL CHAIN catalog of 144 pages has been completed by the Link-Belt Company, Indianapolis, Ind., in which information on older chains is brought up to date, and many new and useful sizes are offered for the first time. When writing for the book ask for No. 1192.

REPUBLIC STEEL CORPORATION, Youngstown, Ohio, has issued a new price card on Toncan Copper Molybdenum Iron Pipe.

The new card, No. 4, embodies a simplified method of computing prices and reflects slight changes in prices of various sizes of Toncan Iron Pipe.

NATIONAL RADIATOR CORPORATION, Johnstown, Pa., has published Bulletin CP-6, the purpose of which is to provide users of condensing and cooling equipment with information about the features of design and construction of National condensing and cooling sections. Descriptions of the uses and of the constructional and operating characteristics of these sections and some comparative data on these and other types of sections, as disclosed by tests, are given in the booklet.

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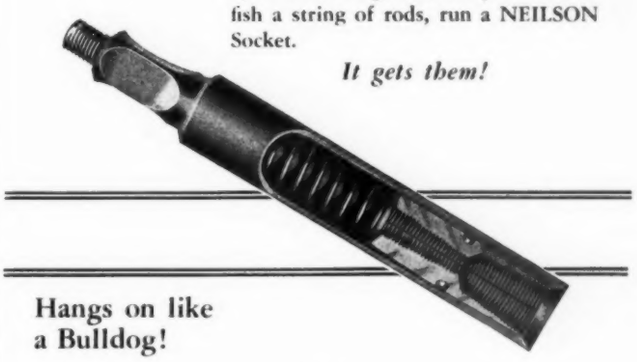

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» » » » » » FURNACE ARCH

By GEORGE

"WHEN an opening is made in a masonry wall it is necessary to provide some means of spanning such opening to support the superimposed masonry. Two methods have been employed by constructors for this purpose. The first involves the use of the beam, girder, cap, or lintel, and the second the throwing of an arch from one side of the opening to the other. Lintels are made of various materials, as wood, stone, reinforced concrete, cast iron and steel, and have cross-sections of different shapes. They are placed across the tops of the openings and transfer laterally the loads above, causing vertical reactions only in the side supports. An arch, on the contrary, is a particular arrangement of blocks of stone or other material put together, generally along a curved line, in such a way that they resist the load by a balancing of certain thrusts and counter-thrusts. An arch exerts on its supports an outward thrust as well as a vertical pressure; and it is this outward thrust which requires that the arch should be used with caution when the abutments are not amply large and strong."

Forms of Arches

"In using arches in architectural constructions, the forms of the arches are generally governed by the style of the building, or by a limited amount of space, rather than by engineering considerations. The problem, therefore, that usually presents itself to the architect is not to design the form and dimensions of an arch that will most economically and, from an engineering point of view, efficiently bear its load, but rather to determine if an arch of a certain form and of certain dimensions will be stable and safe under its load. The semicircular and segmental forms of arches are the best as regards stability, and are the simplest to construct. Elliptical and three-centered arches are not as strong as circular arches, and should only be used where they can be given all the strength desirable.

"The strength of an arch depends very much upon the care with which it is built and upon the quality of the materials. In stone arches special care should be taken to cut and lay the beds of stone accurately, and to make the bed joints thin and close, in order that the arches may be stressed as little as possible in settling.

"The usual method is to build the arch in concentric rings, each one-half brick thick; that is, to lay all the bricks as stretchers and depend upon the tenacity of the mortar for the connection of the several rings. Brick masonry constructed in this way is deficient in strength, unless the bricks are laid in cement mortar which is at least as tenacious as themselves. Another way is to introduce courses of headers at intervals, and to connect pairs of half-brick rings together."

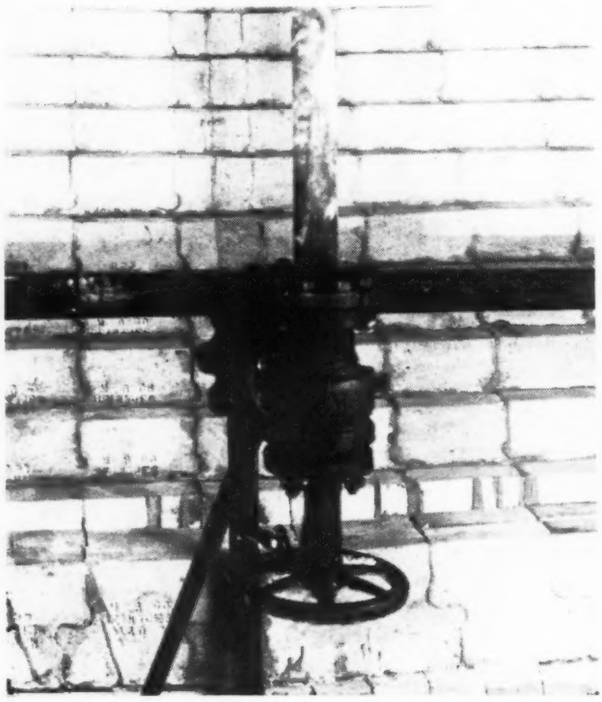


Illustration No. 1:
Showing arch used as a sloping wall floor

Rule for the Radius of Brick Arches

"A good rule for the radius of segmental brick arches over windows, doors and other small openings is to make the radius equal to the width of the opening. This gives a good rise to the arch and a pleasing proportion. In common brickwork, when no particular architectural effect is desired, such as in the rowlock arches thrown over the openings in cellar walls, a rule in very common use is to make the rise of the arch at the crown an inch in height for every foot of span."

Mechanical Principles of the Arch

"In designing an arch, the first question to be settled is the form of the arch; and in regard to this, as already noted, there is generally little choice. When the abutments are of an ample size the segmental arch is the strongest; but when it is necessary to make the abutments of the arch as small as possible, the semicircular or the pointed arch should be used.

"It is a matter of common observation that if an opening is made in a wall, especially in a wall that has stood for some time, the major portion of the masonry above this opening is self-supporting, limited portions only, bounded by a somewhat irregular line, falling down into the opening. The profile of this boundary-line depends upon the nature of the materials of which the wall is constructed, the size of the stones, bricks, etc., the character of the bond and the quality of the mortar. This being the case, all the masonry above an arch should not be considered as the load on it. Some authorities recommend considering as the proper load for brickwork a triangular part of the wall, the sides of which triangle have an inclination to the horizontal of 45°; others assume an inclination of 60°. The exact determination of this load by mechanical laws is difficult, if not impossible. It is better to consider each case separately and by a careful study of the conditions to determine as closely as possible just what portion of the weight of the superimposed masonry is transmitted to the arch."

The above facts pertain to arches in building construction. These data have been compiled through the ages from experience. Even the arches in the Chinese Wall, built on the present-day architectural principles, failed when subjected to the expansion and contraction caused by the summer sun and the winter cold.

As time went on through the various architectural periods, the Greeks and the Romans used flat stone slabs or lintels to span openings. The Romanesque style of architecture used the half-round arch—the Gothic an arch modified from the inverted catinery. During the Byzantine period the architects

P. RENTJES

applied the keystone principle to the building of offset or semi-interlocked tiles.

The application of intense heat created new problems not developed in architectural construction work. Spasmodic attempts were made from time to time by furnace arch builders to develop an arch that would meet the conditions developed in furnace operation and still be universal in their application.

Among the most practical of these was one of the earliest, patented by a Mr. Hennessey (Illustration No. 2, Hennessey Patent). This arch, a semi-circular one with all the tiles having serpentine sides, prevented any one from either raising or lowering independent of the adjacent ones. To make this type of arch applicable to any radius, it is necessary to use a number of serpentine bricks with parallel sides, thus increasing the radius and lowering the proportionate rise of the arch as the span increases. The same is true when building an architectural arch with common refractories. However, the serpentine contour prevents the brick with parallel sides from falling out of place.

The writer's first attempt in the design of an arch was for the purpose of simplifying construction and reducing the labor costs. To all intent and purposes, he relied on the judgment of his predecessors for the stability of the structure. In our original construction we used a split key to take care of the after-shrinkage of the tile so as not to place an undue tension on the lugs. The fallacy of the double lug was soon discovered, in that it prevented adjustment of tile which was necessary to compensate for the warpage.

In his next development, he increased the play between the companion lugs so that each tile could open at its joints as the arch rose from expansion and lowered from contraction. With further experimentation, he discovered that in taking care of the end thrust, if the arch and tiles were supported below the center, preferably in the lower one-third or lower one-fourth, an arch forming a three-point suspension was obtained; instead of one having a four-point suspension, as is the case where a solid skewback support is used. Where a solid skewback support is used, extremely heavy buckstays must be provided to counteract the increased expansion pressure.

Knowing that two objects cannot occupy the same space at the same time, the arches with immovable end supports, when subjected to heat, must either collapse or bend to take care of the increased length, as the shortest distance between two points is in a straight line.

In the case of a sprung arch, it is necessary for the lower face of the arch at the center to be materially higher than the top of the skewback so the arch can raise and relieve expansion pressures. This is necessary for the same reason that you cannot start a locomotive on "dead center." A flat or jack arch will shear horizontally, allowing one-half of the arch to raise and the other half to lower.

In the case of a sprung arch you actually have a three-point suspension, the points of greatest pressure being the top of the skewbacks with the lower part of the arch, instead of the lower part of the skewbacks against the top of the arch.

The major advantage of the base-supported interlocked arch, outside of increasing the leverage for the easy relieving of the expansion pressures, is that you are able to obtain a more uniform reflected radiant heat surface. The advantage of this is well known to all industrial furnace designers.

Among the advantages of a non-metal arch is that it can be insulated to retain heat without having any metal to overheat. Where metal arches are used, the metal must be kept cool to avoid losing its tensile strength.

It was also discovered that contrary to original ideas, the deep interlock was unnecessary as the tiles, when used in a roof arch with proper allowance for the rise and fall of the arch, always remained in compression. This is especially noticeable where the starting tile are supported below the center. Another peculiarity that was discovered was that the joints in the tiles in each haunch would not open, the arch raising toward the center in a straight line regardless of the weight imposed thereon. Thus a comparatively gastight arch was formed.

Illustration No. 1 shows an arch used as a sloping bridgewall floor. The interior furnace width of the boiler being 9 ft. 6 in., no buckstays other than the weight of the boiler walls are used to support the end thrust.

The developments mentioned herein are in use in over one hundred refinery oil stills throughout North and South America, as well as Russia.

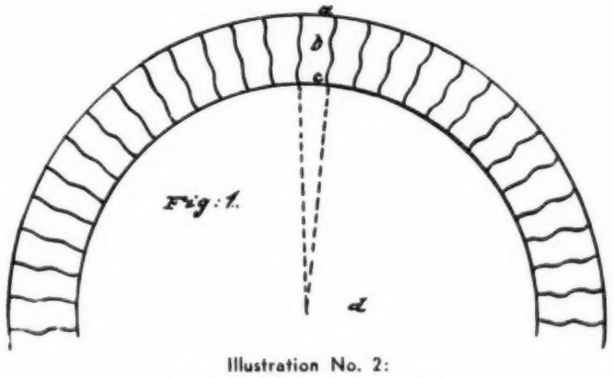
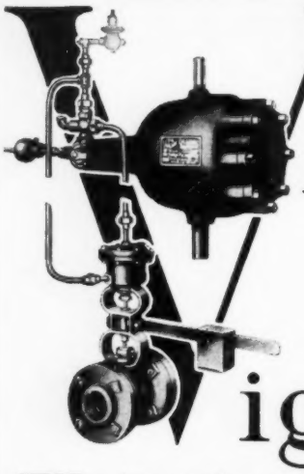


Illustration No. 2:
The Hennessey patented arch



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There is a C-F regulator exactly suited to every requirement of gas control. Well known for more than 40 years. Catalog on request.

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MAKING a good valve is essentially a matter of complete factory facilities, skilled workmen and workmanship, and a third factor which is the most important of all. This is experience, and the knowledge which experience brings to the valve maker.

Jenkins' 69 years of experience are back of this new Jenkins Iron Body Double Disc Parallel Seat Gate Valve.

Sixty-nine years of making Jenkins Valves which have an established reputation for strength to withstand the stresses of the service for which each valve is recommended. Jenkins Valves have the ability to control flow closely. They seat tight when closed and offer minimum resistance when open.

Jenkins' knowledge of the services for which Iron Body Double Disc Gate Valves customarily are used is reflected in the unique Jenkins closing mechanism as in other parts of these valves. Form 143 on request.

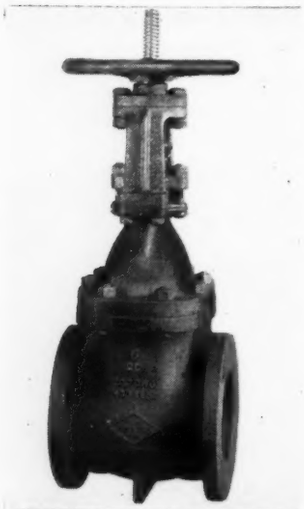

Fig. 875, Jenkins Standard Iron Body Double Disc Parallel Seat Gate Valve, Flanged. Outside screw and yoke, rising spindle.

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Caterpillar Tractor Holds Annual Meeting

THE Caterpillar Tractor Company of Peoria, Ill., held its annual dealers' meeting in Dallas on December 19 and 20. This meeting was attended by officials from the Caterpillar Tractor Company and dealers throughout the southwest territory.

The purpose of the meeting was to show the latest equipment brought out by the Caterpillar Tractor Company, and to hold a general discussion of plans of the company for the year 1933. The first day of the meeting was devoted to demonstrating the new equipment eight miles north of Dallas. The Diesel "Caterpillar" tractor was shown pulling a new-type power controlled "Caterpillar" grader. Also, new tractors equipped with bulldozers and maintenance tools were shown in action. One of the outstanding pieces of equipment was the new "Caterpillar" No. 11 Auto Patrol. At present there are two of these units owned by oil companies in Texas: one by the Humble Oil and Refining Company in the East Texas field and another by the Stanolind Company in the same district.

"Caterpillar" Thirty-five tractor with new all-steel rod and tubing winch pulling tubing

The second day of the meeting was devoted to a general discussion of the equipment shown, together with plans for 1933.

Those attending the meeting from the Caterpillar Tractor Company were: B. C. Heacock, president; George L. Bell, vice-president in charge of sales; E. R. Galvin, sales manager; L. B. Neumiller, service manager; Frank Hanson, supervisor of salesman training; P. R. Ferrell, Texas district representative; W. B. Baufield, Oklahoma district representative, and W. K. Cox, development engineer oil field and pipe lines.

The dealers with representatives attending were as follows: R. B. George Machinery Company, Dallas and Longview, Tex.; Gulf Tractor and Equipment Company, Houston, Tex.; Easton Tractor and Equipment Company, Alexandria, La.; R. L. Harrison Company, Albuquerque, N. M.; Arkansas Tractor and Equipment Company, Little Rock, Ark.; Sheehan & Co., El Paso, Tex.; Rio Grande Company, Harlingen, Tex.; Oklahoma Tractor and Equipment Company, Oklahoma City, Okla.; Tulsa Tractor Co., Tulsa, Okla.; Jack Neal Sales Company, San Antonio, Tex.; Jarvis-Tull Tractor and Equipment Company, Plainview, Tex.; Plains Tractor and Equipment Company, Amarillo, Tex., and Bert Smith Road Machinery Company, Enid, Okla.

Oil Equipment and Engineering Exposition to Be Held in Dallas

Dallas will have its first oil show when the Oil Equipment and Engineering Exposition is held here on April 17 to 23, 1933. Early interest has been great and already a number of large eastern, southwestern and western manufacturers have made arrangements to exhibit their equipment, indicating that the show will be national in scope.

E. G. Lenzner, who is in charge of the Exposition, has secured the Texas State Fair Grounds, where buildings of modern brick and steel construction are available and ample out-door space is provided for the exhibiting of larger equipment.

The facilities included in the Fair Grounds are electric current, gas, compressed air and water. The entire exhibit space is on one floor, with large doors in all sections of the building for use in driving equipment directly to the booths, with trucks. A railroad siding is also available for shipping in all heavy machinery and equipment.

There have been many new equipment developments in the past two years; manufacturers have made radical changes, improvements and designed new tools, machinery and equipment which will greatly interest drilling, production, refining, natural gas, transportation and marketing men of the industry.

Additional information may be secured from E. G. Lenzner, P. O. Box 301, Dallas, Texas.

Maintenance Engineering Appointed Representatives

Maintenance Engineering Corporation, Houston, Texas, has been appointed representative of the Emil Greiner Company, New York, N. Y., manufacturers of instruments, laboratory glassware and apparatus.

A complete line of instruments and glassware will be carried in stock at Houston. R. E. O'Neill, sales representative of the Maintenance Engineering Corporation, will have charge of this account.

Tide Water Merges Mid-Continent Subsidiaries

The Tidal Oil Company, organized under the laws of Oklahoma, has changed its name to Tide Water Oil Company, and has taken over all of the business and properties of Associated Producers Company, Tidal Refining Company and the Tide Water Oil Sales Corporation in the Mid-Continent territory.

The Tide Water Oil Company of Oklahoma, subsidiary of the Tide Water Oil Company of New Jersey, will carry out all contracts of the four companies listed above, and will have the identical management previously in control of the four reorganized companies.

Humphreys Retires from Standard Oil Company

After nearly thirty-three years of service, Dr. R. E. Humphreys retired the first of the year from his position as vice-president in charge of manufacturing and from membership on the board of directors of the Standard Oil Company. His action was occasioned by his reaching the age of retirement specified under the company's annuities plan.

Earl A. Carr Succumbs to Pneumonia

Earl A. Carr, assistant manager and chief petroleum engineer in the Southwest division of the Pure Oil Company, succumbed to an attack of pneumonia in Tulsa on December 29. Mr. Carr, 39 years of age, was one of the leading engineers of the oil industry. He had been affiliated with the Pure Oil Company for the past 13 years.

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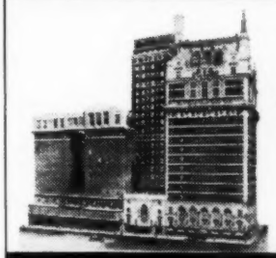

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Otto Schubert, Jr., *Mgr.*

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Improved in design, materials and workmanship, handier, stronger. Features include: Forged-in lugs that give jaws greater bearing on the bar; large steel bolt; drop-forged alloy steel shackle; jaws of special steel, hardened, tempered and tested; handles forged from high carbon steel, have both stiffness and spring; chains proof tested to two-thirds catalog strength (3,600 to 40,000 pounds).

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Renew Your Subscription Now!

Calculation and Correction of Ignition and Valve Action

By F. B. TAYLOR, JR.☆

EFFICIENT operation of any gas or gasoline power unit depends to a very great extent upon the accuracy of ignition, valve and cam action. Frequent and thorough checks should be made of every event throughout a complete turnover of the power cylinders to assure delivery of the rated horsepower.

Present trends and the exacting demands of competition require a high degree of operating efficiency with the lowest possible maintenance costs. This holds true at the smallest power house just as it does at larger installations, both in the field and on main lines. However, at both locations, it is frequently a difficult task to properly check and adjust for cam and ignition action.

Practically without exception, whether of a field or station type, power units are checked for all events from dead center. On vertical, multi-cylindered engines the top dead center on No. 1 cylinder, compression stroke, is recognized as zero on the flywheel. Horizontal and horizontal tandems zero the flywheel at dead center on the compression stroke, No. 1 cylinder, but the cylinders may be numbered either from or toward the flywheel. Each event following compression is then designated by the number of degrees from zero.

Accuracy in the location of 0 degree on the wheel is all-important. On a horizontal type of power unit absolute dead center is best arrived at in the following manner: Roll the engine over until the piston in No. 1 cylinder has advanced a little more than one-half its traveling distance on the compression stroke. Allowing the piston to remain in this position, which need not be exact, mark the position of the crosshead on the crosshead slide. Also, immediately above a fixed pointer, mark the flywheel.

Continuing the movement of the piston in No. 1 cylinder through the compression stroke, the crosshead will be carried through its rest and back to the previous mark upon the crosshead slide. By again marking the flywheel in its new position, absolute zero, or dead center, is at a point exactly half way between the first and second markings on the flywheel.

Vertical engines, or units without crossheads and slides, can be dead-centered in the same manner by using the cylinder wall, either above or below the piston in place of the crosshead and slide. This method of determination of dead center is far more accurate than attempting to bring No. 1 piston to a position of absolute rest at the end of its compression stroke.

TABLE OF ARC MEASUREMENTS FOR SOME FLYWHEELS OF THE SIZES IN COMMON USE

Diameter of Wheel	*Spacing in Inches*
10-Degree Arc	
5′ 0″	5 15/64
5′ 2″	5 13/32
6′ 0″	6 9/32
5-Degree Arc	
7′ 3″	3 51/64
8′ 0″	4 3/16
8′ 3″	4 21/64
10′ 0″	5 15/64
12′ 0″	6 9/32
14′ 0″	7 19/64

Proper graduation of the wheel is from dead center, against the direction of rotation, in arcs of either five or ten degrees. Punch marks, two inches apart, across the face of the wheel with a chisel-cut between and degrees in numerals above, makes a neat-appearing graduation.

It is an advantage in graduating a wheel to measure exactly opposite the zero marking to 180 degrees and from these two points locate 90 degrees and 270 degrees. This tends to adjust the decimal point in the calculation of the spacing between the degree markings.

On factory graduated flywheels it is well to check the degree graduation, as slippage and shaft adjustment will tend to advance the markings. Most flywheels graduated previous to installation are zeroed from the center of the keyway, the keyway cut being in line with the center of the crank. However, this applies only to certain types of engines of low horsepower ratings.

Frequently, when it is desirable to check an engine, a complete chart of events, correlated to flywheel graduation, is not at hand, although it is seldom that the action in No. 1 cylinder is not readily obtainable. From this it is necessary to calculate and complete the series through two revolutions of the flywheel, and for each of the cylinders.

Disregarding the consideration of two-cycle equipment entirely, suppose that the exhaust valve, No. 1 cylinder, closes at 26 degrees on the first revolution of a three-cylinder power unit. To find the point at which the exhaust valve closes in the cylinder next in firing order, divide the number of degrees in a complete turnover of the unit; or 720 degrees by three, the number of the cylinders. The answer, or 240, plus the original 26 degrees will be 266 degrees, or the point in question. When the sum total of the original action and the added number of degrees exceeds 360, the action in question occurs during the second revolution, as: The inlet opens at 350 degrees first revolution. Here the total is 590 degrees, or 230 degrees (590-360) within the second revolution.

Calculation for a four- or an eight-cylinder unit is the same except that the complete turnover, or 720 degrees, is divided by four for a four-cylinder unit and by eight for an eight-cylinder unit, etc.

The greatest assurance of an efficient delivery of power is frequent and complete checks of the ignition from the compression stroke, and valve action from the suction stroke, against a graduated flywheel.

☆ Panhandle Eastern Pipe Line Company, Louisburg, Kan.